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The Journal of the Society for the
Study of Alchemy and Early Chemistry

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Prof. LYNN THORNDIKE

Dr. E. ASHWORTH UNDERWOOD

7-9
VOLUME VII

1959

W. HEFFER & SONS LTD.,
CAMBRIDGE, ENGLAND

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VOL. VII

FEBRUARY, 1959

No. I

SOME MEDIEVAL TEXTS ON COLOURS

BY LYNN THORNDIKE*

My purpose, here, is to call attention to a number of treatises on colours in medieval Latin manuscripts which have either not been noted at all, or been inadequately described in catalogues, and to edit two of them and a portion of a third. Of these, one is theoretical and philosophical, treating of the species of colours and their relation to the four elements and qualities, and to the humours and spirits. It is, perhaps, by Urso, or at least belongs to his school of thought. The other two, and most of those which are here noticed but not edited, are of a practical character and intended for the use of painters, illuminators and dyers. A possible exception is one, which we shall add by way of contrast, from the 16th century, and which might well seem to be intended more for classical scholars and antiquarians than for artists and artisans. The practical works are all in a simple style, and with similar wording such as: *funde, mitte, pone, rade, and valde pulchrum*.

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I

Since Latin MS. 6552 at the Bibliothèque Nationale, Paris, of the 14th century, is not mentioned by Corbett¹ or by Johnson², a text on colours at fols. 26r.a–28r.b may be briefly noticed here. It opens and closes:

Simplices colores sunt quicumque elementis consecuntur ut igni et aeri
et aque et terre . . ./. . . ex hiis que sunt circa colores maxime utique
aliquis que dicta sunt potest videre.

It is here anonymous, as it is in a Cambridge manuscript catalogued by Mrs. Singer³. But, with the variant forms of incipit,

“Simplices colorum sunt . . .”⁴ and “Simplicia colorum sunt . . .”⁵,

it was commonly ascribed to Aristotle.

Treatments of colours in Latin MS. 7400A of the Bibliothèque Nationale, of the 13th century, have been noted by both Corbett and Johnson. But Corbett gives their foliation as 27–32v. and 44v.–46; Johnson, perhaps restricting the folios to those containing recipes from *Mappae clavicula*, gives 28r.–30r. and 44v.–46r. As we shall see, they rather occupy fols. 27r.a–30r.a, and fols. 40v.a–46r.b in part. On the front cover of this manuscript in impressed gold letters is written:

AGINUS PHILOSOPHUS (i.e. Hyginus)
DE IMAGINIBUS CAELI
ANSELMUS DE IMAGINIBUS MUNDI
MODUS AGENDI COLORES
DE EXTRAVAGANTIBUS NOVIS
EXPERIMENTIS AURI
ARS AD ARMA FACIENDA

The *Modus agendi colores* begins at fol. 27r.a with the rubric

Modus agendi colores et distemperandi. De synopide⁶,

¹ James Corbett, *Catalogue des manuscrits alchimiques latins, I, Manuscrits des bibliothèques publiques de Paris*, Bruxelles, 1939.

² Rozelle P. Johnson, “Some Continental Manuscripts of the *Mappae Clavicula*”, *Speculum*, XII (1937), 84–103.

³ Dorothea Waley Singer, *Catalogue of Latin and Vernacular Alchemical Manuscripts in Great Britain and Ireland, II* (1930), item 876, Fitzwilliam Museum, Maclean Bequest 154, fol. 248v. It is here found, however, with other works of Aristotle.

⁴ Thorndike and Kibre, *A Catalogue of Incipits of Medieval Scientific Writings in Latin*, 1937, 692.

⁵ *Aristoteles Latinus, I* (1934), 90, 189.

⁶ Corbett omits these last two words.

and the incipit as given by Corbett. Subsequent headings and opening words are as follows:

- 27r.a *Item alius et melius.* Modus alius faciendi sinopidem
 27r.b *De rosino faciendo.* Colorem roseum hoc modo conficies valde pulcrum. Accipe album hispanicum vel gipsum
 27v.a *De roseo colore.* Ad scribendas litteras roseas valde pulcras. Accipe glaream ovi
Item de alio modo. Alius modus scribendi litteras valde pulcras. Accipe fel magni piscis ulgovardi
Qualiter fit adurium. Secundum Hermetem patrem philosophorum ad adurium faciendum sume vitri pulveris partem unam, sulphuris vivi partes duas, argenti vivi partes tres
 27v.b *Lapis aureus auri colorem habens fit ita.* Salis optimi et auri-pigmenti partes equaliter sumptas
 28r.a *Modus faciendi adurium.* Adurium valde bonum et electum hoc modo fit. Accipe laminas argenti purissimi
 28r.b Alius modus ad idem. Accipe colophonie partem unam, pice resine partem unam
 28v.a *Aliter.* Item alius modus faciendi lazurium. Accipienda est lapis lazuli electus
 28v.b *Item aliter.* Adurium bonum hoc modo fit. Accipe pulverem gipsi
 29r.a Si aliud adurium volueris facere, accipe ampullam purissimi cupri
Item alius modus faciendi adurium. Accipe flores blavos et tere
Compositio vermilionis. Accipe unam libram surfuris vivi
 29r.b Vermilium sinnabaturn grece vocatur

Across the bottom of the page below both columns is written in a small hand:

- Vidi de vermilio sicut suprascriptum est sed adulterinum bullivit diu ad ignem sine flamma donec sentivimus combusta illud esse durum, quo mox inde remoto sepelivimus illud in cineribus usque ad gulam(?) usque in crastinum.
- 29v.a Si volueris facere viride grecum, accipe ollam novam et mitte in eam laminas purissimi cupri
Viride Rothomagense sic fit. Accipe laminas purissimi cupri
 29v.b Si vis facere minium rubeum vel album
Ita debes facere indicem colorem.
 30r.a Colores in pergamento spissi et clari hii sunt

There follow two notes in a smaller hand at the bottom of the column. There-with the treatment of colours ceases and at fol. 30r.b we have a recipe for making cement, and

Quomodo possit fundamentum eternum statuere
 Quomodo vivum argentum possit augmentari

and so on. Presently the recipes become medical with a remedy for toothache, a way to detect leprosy, to expel stones, avoid fever and the like.

After two blank leaves (33-34) the extravagant new experiments⁷ are at first metallic, but after a few leaves become colourful and begin *De sinopide* again.

- 40v.a Synopis aut sinopita vel sinopida fit hoc modo
Seriton ita fit
Psimithin ita fit
- 40v.b *Quomodo fiat lacca.*
Temperata urina ut transeat in colorem cetrinneum.
- 41r.a Sanguis draconis ita fit
Bolum armenicum ab Armenia ducitur
- 41r.b Lulax id est indicum ita fit
Alia compositio lulacis.
- 41v.a Azurium usitatum sic fit
- 42r.b Principale fit adurium hoc modo. Violas optime tritas in mortario mundo
- 43r.b Violaceus autem color qui dicitur auricella vulgariter
Porphiretitus color. Limatura plumbi stanni eris rubei
- 43v.a Lapis aureus auri colorem habens
Si vero pulcherrimum virorem

After recipes how to turn iron to steel, make pearls, *es ustum*, marchasite, and the like, we come back to colours with

- 44r.b Ut autem cuiuslibet rei colorem in aureum immutes
Ad colorem argenteum.
- 44v.a Auripigmentum coloris aurei

and at 45r.a-v.a several recipes for writing golden letters and inscriptions. Also silver letters at 45v.b-46r.a, then *Ad colorem viridem facere*, and *Qualiter pelles tinguntur* for a full column (46r.a-b). But these are interspersed with other recipes such as

- 45v.b Plumbum similem argento facere.
Eris commutatio.
- 46r.a Conpositio electri.
- 46v.a Qualiter acetum debeat fieri.
- 46v.b Separatio auri ab argento.

The *Ars ad arma facienda* of the same manuscript also includes some recipes for minium, ceruse or album hyspanicum, and vermilion, but is chiefly given over to tricks and magical illusions.

⁷ See Corbett for titulus and incipit. Extravagant is here used, as in the case of papal decretals, of experiments not included in the common collections.

Although in general the two texts differ widely, a few of the foregoing recipes for colours between fols. 29r.a and 30r.a, while varying in wording, correspond roughly to some of those in Sloane 1754, published by D. V. Thompson Jr in *Speculum*, I (1926), 280–307. Thus the first two recipes for making azure at 29r.a correspond to the last two on page 292; those for verdigris and green of Rouen at 29v.a to the next to last two on 294; that for making minium white or red at 29v.b to that on page 296; and “Colores in percameno spissi et clari” on 30r.a to “Colores in percameno clari et spissi” on page 288⁸. It will be seen that even these recipes do not occur in the same sequence in the two manuscripts. The recipe for making cement appears to be quite different in the two:

B.N. 7400A, fol. 30r.b.

Ad cementum tenatissimum. Accipe
tegulas et testas

Speculum, p. 298.

Decemento faciendo. Cementum quod
semel siccatum nullis umquam rum-
pitur aquis. Accipe calcem vivam
pulverem tegule paleam ferri

Although Mrs. Singer's Catalogue includes no fewer than thirty-nine items from Corpus Christi College, Oxford, MS. 125, it omits fols. 34r.–39r., although it lists from other manuscripts two of the texts found there. The first of these seems in part identical with that published by Thompson from Sloane 1754 and for which Mrs. Singer's Catalogue (II, 607, item 907) also lists Harley 273, fols. 209–212v. In Corpus 125, fol. 34r., it has the same titulus and incipit as in Sloane 1754:

Incipit liber de coloribus illuminatorum sive pictorum. Viride⁹ terrestre
molendum est cum aqua sicut ceteri colores

The next paragraphs open on fol. 36r.:

Colores in percameno spissi et clari hii sunt
Si autem vis facere rubeum minium vel album

and so correspond more closely with Sloane 1754 (see *Speculum*, I, 288, 296) than with B.N. 7400A. But on fol. 36v. the treatment of colours breaks off and the lower half of the page is occupied by what appears to be an alchemical text, opening,

. . . videbatur eius porticus plena catulis super faciem terre gradienti-
bus. Post multos vero dies . . .

⁸ The five lines there quoted are, except for minor variants, identical with one of the *Addenda* in Hendrie's edition of Theophilus, 1847, p. 418, “Ab Eraclio excerptum”. Also cf. its “Azorium incidet in nigro, maptizabis de albo plumbo”, with Hendrie's “Azorium incidet de nigra maptizabis auripigmento”.

⁹ This word was incorrectly given as *Inde* in Coxe's Catalogue of MSS. in Oxford Colleges.

and followed by a recipe for catching doves. At fol. 37r. opens the well known *Liber ignium* of Marcus Grecus, for which Mrs. Singer (II, 633-34, item 979) lists eight other manuscripts. It is followed on fol. 38r. by

Nota quod sal petrus est minera terre que reperitur in scopulis circa lapides seu in edificiis Sarracenorum antiquissimis
Pro colore croceo numquam deficiente

Other colours follow on fol. 38v. At the top of 39r. is a "Capitulum perfectum ad aurum", opening, "Recipe vitrioli partem unam . . .".

Another Oxford College manuscript not listed in Mrs. Singer's Catalogue is Merton 324, although nine other Merton manuscripts are cited there. Yet, after the extraction of two medicinal waters from flowers at fols. 229v.-230r.:

Ad dissolvendum fleumaticos humores circa spiritualia. Extrahatur aqua de floribus ysopi lenistici satureya
De discrasia scamosa. Extrahatur aqua de floribus violarum vel malvarum

various colours are given at fols. 230v.-232r.:

De vermiculo. Si vis facere vermiculum accipe ampullam vitream
231r. De azorio. Cum volueris facere azorium accipe ollam novam que numquam fuit ad opus aliud . . . (cf. *Speculum* I, 292).
Item de azorio. Mittes et addas ad azorium factum(?) sic
Item de azorio. Tertio modo facies azorium. Accipe flores blavos . . . (cf. *Speculum* I, 292).
Nota. Azorium color est optimus et pulcherrimus.
De flore eris. Si vis facere viridem grec' accipe ollam novam et mitte in vase laminas puri cupri . . . (*Speculum*, I, 294).
231v. De mimis (sic). Si vis facere mimium (sic) album vel rubeum (*Speculum*, I, 296).
De auri pigmento. Auri pigmentum secundum sui nominis ethimologiam auri speciem representat quomodo vermiculum sit et ipsum distempera.
De colore indico. Color indicus sic fit. Succum de baccis ebuli collige . . . (cf. *Mappe clavicula*, *Archaeologia*, 32 (1847), 208).
De ligno brasilio. Brasilicum lignum est rubeum durum et obscurum secundo gradu a vermiculo
Nota. Vermiculum et brasilicum ne caleferis ad ignem quoniam ignis calore color eorum perit. Vermiculum in sole proficit.
De croco. Crocus flos esse dicitur et probatur
De colore roseo. Si rosam facere velis sic facies. Accipe
De colore viridis.
232r. Nota. Pulveriza subtiliter noctilucam et adde de gummi arabice.
De auracione cupri.
De auracione argenti.
Ad cocleam deaurandum.
De colore saphirico super arg'.

Nota de sanguine rub' hominis.
 De cerebro animalis.
 De ampulla vitrea.
 Ad consolidanum nitrum.
 Color similis auripigmenti.

The remaining recipes and experiments are not concerned with colours and end on fol. 234r., as does the manuscript. All the foregoing items were catalogued together by Coxe under the single caption, "Libellus experimentorum pro diversis", with the incipit, "Ad dissolvendum flemmaticos humores . . .", which explains why they were overlooked in Mrs. Singer's Catalogue.

II

For the work on colours attributed to Urso I have used three MSS.: at the British Museum, Royal 12.E.XV, fols. 17r.-18v., and Sloane 1933, fols. 137v.a-138r.a, both dated in the catalogues as 13th century, and Vienna 5207, fols. 112v.-116r., a very legible and usually dependable, albeit later copy of the 15th century. Neither British MS. is listed in Mrs. Singer's catalogue. I have long had a photostat of Vienna 5207, for this text and collated my transcription of it with the other two MSS. in the summer of 1958. Curt Matthaes, *Der Salernitaner Arzt Urso aus 2 Hälften des 12 Jahrhunderts und seine beiden Schriften "De effectibus qualitatum" und "De effectibus medicinarum"*, Leipzig Diss., 1918, 74 pp., referred to the Vienna MS. of the work on colours, but gave the incipit incorrectly as "Primo videamus quid sit color . . .".

URSO DE COLORIBUS

r = Royal 12.E.XV; **s** = Sloane 1933; **v** = Vienna 5207

Tractaturi¹⁰ de coloribus primo videamus¹¹ quid sit color et quot sint species coloris¹², deinde¹³ quomodo vel ex quibus fiant, ultimo quare ex coloribus non ita ut ex saporibus rei¹⁴ natura certificetur¹⁵.

Color itaque¹⁶ est proprietas visu¹⁷ perceptibilis. Color¹⁸ autem alius accidentalis, alius naturalis; accidentalium alius¹⁹ transitorius, alius permansivus²⁰; transitorius ut²¹ rubor²² ex²³ verecundia et alii²⁴ similes. Unde Averroes

¹⁰ **r** Practaturi. ¹¹ **r**, **s**, quid sit color videamus.

¹² **v** colorum. ¹³ **s** omits.

¹⁴ **v** natura rei.

¹⁵ **r** certificatur.

¹⁶ **v** omits. ¹⁷ **s** proprie visu. ¹⁸ **v** Colorum.

¹⁹ **r**, **s** alius est.

²⁰ **v**, permanens. ²¹ **s** ita ut. ²² **v** rubedo. ²³ **v** ut.

²⁴ **v** omits.

dicit huiusmodi colores esse passibiles qualitates et non passivas²⁵. Permanens alius ex artificio est, ut ille²⁶ qui fit²⁷ in pannis ex²⁸ tinctura et²⁹ in ymaginibus ex pictoribus³⁰; alius ex adustione³¹ ut in Ethiopibus niger³² vel ex frigidityte ut albus in Scotis. Isti³³ namque colores ex³⁴ consuetudine conversi³⁵ sunt in naturam. Nam teste³⁶ Ypocrate consuetudo est altera natura.

Naturalis autem³⁷ color aut est³⁸ ab elementis³⁹ aut ex qualitatibus. Ab elementis innatis principaliter aut aliis mediantibus. Sed sive⁴⁰ naturalis sive accidentalis, alius est albus, alius niger, alius medius. Accidentaliter vero color aut fit ex eis que sunt in prima compositione, aut ex eis que sunt in secunda, vel⁴¹ ex eis que sunt in tertia. Sed qui fiunt ex hiis⁴² que sunt in prima aut fiunt ex eorum qualitatibus aut ex eorum substantiali⁴³ admixtione. Ex eorum qualitatibus, ut ex qualitate⁴⁴ huius ignis elementati fit color rubeus vel albus vel niger secundum diversitatem subiecti in quod⁴⁵ agit agens. Namque in lignum vel⁴⁶ lapidem primo denigrat, quoniam ex calore ipsius et siccitate quedam fumositatis⁴⁷ terrestribus⁴⁸ resoluta et⁴⁹ inspissata circa superficiem denigrat. Sed ex diuturna caloris⁵⁰ actione in subiectis⁵¹, cum non inveniuntur partes⁵² subtiles⁵³ et liquide in quas debet⁵⁴ agere, resolvit terrestres in aquosas, que, cum sint fluxibiles, naturaliter circumfunduntur per unamquamque superficiem, et sua albedine dealbat⁵⁵ (v fol. 113r.). Quandoque autem⁵⁶ facit colorem rubeum ut in hebeno⁵⁷ que dum apponitur ad ignem pro sui⁵⁸ nimia compactione substantie et habundantia terrestrium partium non facile comburitur nec flammam a se emittit, sed ex calore ignis facilius liquide et tenues partes extenuantur⁵⁹. Unde cum aqueose et aeris partes extenuantur in igneas et ignee⁶⁰ sui⁶¹ subtilitate per unamquamque superficiem circumfunduntur, fit⁶² rubeus color et in aliis similiter.

²⁵ v passiones.

²⁶ r, s omit. ²⁷ r, s omit. ²⁸ r et. ²⁹ s aut; r omits to alius.

³⁰ s pictura. ³¹ r ustione. ³² v omits.

³³ r Illi. ³⁴ r ex diuturna. ³⁵ v versi.

³⁶ r testatur Ypocrates.

³⁷ r omits. ³⁸ v inest. ³⁹ v omits to innatis.

⁴⁰ v sive sit.

⁴¹ r, s aut. ⁴² r eis.

⁴³ r generali.

⁴⁴ v qualitatibus.

⁴⁵ r quo (17v.) accidit accidens.

⁴⁶ r, s vel in. ⁴⁷ r, s cum. ⁴⁸ r, s terrestribus partibus. ⁴⁹ v omits.

⁵⁰ s actione caloris, v caliditatis actioni. ⁵¹ r subiectum.

⁵² r subtiles partes. ⁵³ s substantiales. ⁵⁴ r debeant; s debeat.

⁵⁵ r, s, dealbant. ⁵⁶ r omits.

⁵⁷ s ebeno. ⁵⁸ v summa for sui nimia.

⁵⁹ r, s omit to next extenuantur.

⁶⁰ v igne. ⁶¹ v subtilitate sui. ⁶² r, s et fit.

Eodem modo ex hoc aere elementato diversi fiunt colores ut albus rubeus lividus⁶³ et niger. Nam si aer fuerit non⁶⁴ frigidus⁶⁵ valde, ex frigidityte⁶⁶ ipsius constringuntur vie per quas sanguis cum aliis humoribus⁶⁷ consuevit⁶⁸ ad⁶⁹ cutem attrahi. Unde cum ex humoribus cutis⁷⁰ non coloretur, alba apparet prout debet esse naturaliter, quoniam, cum constet ex quatuor humoribus elementatis, et aqua sit fluxibilis et liquida sua fluxibilitate et liquiditate circumfulsa per superficiem, prout est⁷¹ alba naturaliter⁷² albam disponit cutem. Quod si magis sit⁷³ aer⁷⁴ frigidus, lividum prestat colorem quoniam⁷⁵ ex maiori frigidityte eius calor mortificatur⁷⁶ in cute, unde ignee partes⁷⁷ et aeree ratione constrictionis condensantur in aquosas et terrestres⁷⁸, ex quibus fit color lividus. Neque enim⁷⁹ fit⁸⁰ albus ex frigidityte⁸¹ aque propter terram neque⁸² niger ex terra propter aquam, sed fit quidam color medius inter nigrum⁸³ et album scilicet lividum qui est⁸⁴ ultra album et infra nigrum. Quod si multo magis fuerit aer frigidus et egerit in subiectum, maior fit⁸⁵ mortificatio, ita quod non solum ignee et⁸⁶ aeree partes condensantur in terrestres sed etiam aqueose. Unde per⁸⁷ superhabundantiam terrestrium partium que naturaliter⁸⁸ sunt nigre, fit⁸⁹ niger color. Quod si aer fuerit calidus non tamen immoderate vel diutius egerit in subiectum⁹⁰, fit⁹¹ color rubeus, quoniam ex calore aeris (v fol. 113v.) exsiccatur⁹² et ratione vacuitatis sanguis ad eam attractus⁹³ secundum sui colorem cutem disponens facit⁹⁴ eam rubeam⁹⁵. Quod si diutius egerit in substantiam sanguinis ad⁹⁶ cutem attracti, ex diuturna caloris⁹⁷ actione aduritur ex⁹⁸ adustione, cum liquide partes attenuantur⁹⁹ et superhabundent terrestres¹⁰⁰, denigratur¹⁰¹ et denigratus cutem denigrat.

⁶³ r, s niger lividus. ⁶⁴ s omits ⁶⁵ v valde frigidus. ⁶⁶ v ipsius frigidityte.

⁶⁷ v humoribus elementatis. ⁶⁸ s, solet. ⁶⁹ r, s attrahi ad cutem.

⁷⁰ r, s sanguis.

⁷¹ r omits. ⁷² r similiter.

⁷³ v est. ⁷⁴ v omits. ⁷⁵ s quia.

⁷⁶ v mortificatus. ⁷⁷ v et aeree partes.

⁷⁸ r, s terrestres partes.

⁷⁹ r, s autem. ⁸⁰ r, s est. ⁸¹ r, s aque proprietate, and omit through terram.

⁸² r, s nec. ⁸³ r album et nigrum.

⁸⁴ r omits.

⁸⁵ s erit.

⁸⁶ s partes et aeree. ⁸⁷ v pro superhabundantia. ⁸⁸ s sunt naturaliter.

⁸⁹ v color fit niger.

⁹⁰ v substantiam. ⁹¹ v rubeus fit color.

⁹² v desiccatur. ⁹³ r, s tractatus.

⁹⁴ r, s omit. ⁹⁵ r, s add reddit.

⁹⁶ r, s attracti ad cutem. ⁹⁷ v actione caloris.

⁹⁸ v et ex. ⁹⁹ v extenuentur.

¹⁰⁰ r, s add partes. ¹⁰¹ r, s denigrantur et denigrati denigrant cutem, et ita fit niger color.

Discernitur autem niger ex¹⁰² frigiditate factus a colore nigro qui fit per calorem per obscuritatem. Ipse namque¹⁰³ qui¹⁰⁴ fit ex frigiditate est obscurus, qui fit ex calore est cum claritate.

Ex aqua elementata similiter varii fiunt colores et secundum sui qualitates et substantiali admixtione¹⁰⁵, cum admiscetur¹⁰⁶ aliquibus¹⁰⁷ et predominatur admixtis, alterat ea¹⁰⁸ sui colore et reducit ad suum¹⁰⁹ proprium colorem id est ad¹¹⁰ album. Ex frigiditate¹¹¹ aque diversus fit color, ut de aere¹¹² diximus (s fol. 137v.b).

Ex¹¹³ terra color innascitur et alterat cum aliquibus substantialiter admiscetur que¹¹⁴ commixta ad proprium reducit colorem si eis prehabundet.

Ex eis que sunt in secunda compositione, ut ex fructibus et¹¹⁵ herbis et aliis cibis¹¹⁶ et potibus diversi fiunt colores. Ex herbis namque et succis earum multi¹¹⁷ fiunt colores secundum diversitatem succorum¹¹⁸ et colorum herbarum. Ex fructibus ut ex gallis ex quibus fit¹¹⁹ niger color ut in attramento¹²⁰. Si galle contrite bulliant in aqua pluviali, que naturaliter siccior est, que etsi non sint nigre, tamen quia terrestres sunt, quandam proprietatem trahunt in aquam ex terra, et quedam terrestris humiditas ex his¹²¹ resolvitur¹²² et¹²³ aque admiscetur et post ex admixtione¹²⁴ vitreoli aduritur¹²⁵ et denigratur; ex gummi arabico¹²⁶ conglutinatur ut non fluat. Ex cibis et potibus, ut ad exemplum habeatur unum pro multis, quia¹²⁷ longum est singula discutere, colores fiunt hoc modo. Cum aliquis (r fol. 18r.) plurimo utitur¹²⁸ vino et precipue (v vol. 114r.) forti, ab¹²⁹ huiusmodi calida et multa resoluta fumosititas sua humiditate¹³⁰ veniens ad superficiem rubeam¹³¹ redit.

¹⁰² r, s factus ex frigiditate.

¹⁰³ r vero; s enim. ¹⁰⁴ r, s omit to next qui fit.

¹⁰⁵ s commixtione. ¹⁰⁶ r commiscetur. ¹⁰⁷ s omits to alterat.

¹⁰⁸ r eas a; s, ea a. ¹⁰⁹ r, s omit.

¹¹⁰ r, s omit. ¹¹¹ no note. ¹¹² r, s frigido aere.

¹¹³ v De.

¹¹⁴ v quia.

¹¹⁵ r, s omit.

¹¹⁶ r, s et cibis.

¹¹⁷ v fiunt multi. ¹¹⁸ v colorum herbarum et succorum.

¹¹⁹ v niger fit color. ¹²⁰ r, s encausto.

¹²¹ s eis. ¹²² v resoluta. ¹²³ v omits.

¹²⁴ v appositione. ¹²⁵ v denigratur et aduritur.

¹²⁶ r quasi.

¹²⁷ s quia naturaliter esset longe discutere per singula.

¹²⁸ s cibo utitur.

¹²⁹ r ad.

¹³⁰ v levitate. ¹³¹ r, s eam redit rubeam.

Ex hiis que sunt in tertia compositione, scilicet humoribus¹³² et spiritibus, varii fiunt¹³³ et diversi colores¹³⁴ hoc modo. Ex spiritibus color fit rubeus¹³⁵ ut in nascentibus, cum valde dilatatur cor, multus excipitur¹³⁶ spiritus et calidus pro dilatione scilicet cordis qui subito et in multa quantitate cordis¹³⁷ constrictione veniens ad exteriora ea calefacit¹³⁸ et cutem¹³⁹ rubeam¹⁴⁰ reddit. Quandoque autem ex¹⁴¹ spirituum absentia et humorum color fit pallidus¹⁴² ut in timentibus, in quibus pro cordis constrictione et¹⁴³ sanguine et spiritu interiora petente cutis remanet pallida¹⁴⁴.

Color autem qui ex¹⁴⁵ humoribus inest, alius¹⁴⁶ secundum naturam, alius preter naturam. Secundum naturam color¹⁴⁷ est commixtus ex rubeo¹⁴⁸ et albo et¹⁴⁹ ex temperantia et¹⁵⁰ humorum quantitate¹⁵¹. Neque¹⁵² enim est albus ex¹⁵³ frigidis humoribus neque¹⁵⁴ rubeus ex¹⁵⁵ calidis, sed uterque¹⁵⁶ medius inter utrumque. Albus autem ex flegmate fit, quia cum sit album subcutaneum¹⁵⁷ factum, cutem que naturaliter est alba dealbat, ut in flegmaticis. Ex sanguine autem¹⁵⁸, cum sit rubeus, superposita¹⁵⁹ cutis redditur rubea, ut in sanguineis. Ex colera, cum non¹⁶⁰ sit naturaliter rubea¹⁶¹ sed ex citrinitate attinente,¹⁶² color quidam fit rubeus citrinitati iunctus. Ex melancolia naturali, cum non sit perfecte nigra sed glauca, cutis¹⁶³ secundum¹⁶⁴ glaucum colorem disponitur. Ex melancolia innaturali tamquam nigra color redditur niger.

Preter naturam vero ex humoribus color innascitur ex defectu virtutum in corpore et ex humorum superhabundantia¹⁶⁵. Ex defectu¹⁶⁶ virtutum, ut

¹³² v spiritibus et humoribus.

¹³³ v et diversi fiunt. ¹³⁴ v omits. ¹³⁵ r, s rubeus hoc modo.

¹³⁶ v concipitur.

¹³⁷ r constrictione cordis.

¹³⁸ r calefecit. ¹³⁹ r, s omit. ¹⁴⁰ r, s rubea.

¹⁴¹ r, s omit. ¹⁴² v palidus.

¹⁴³ v omits.

¹⁴⁴ v palida.

¹⁴⁵ r ab; s omits. ¹⁴⁶ v alius est.

¹⁴⁷ v est color. ¹⁴⁸ v albo et rubeo.

¹⁴⁹ r, s omit. ¹⁵⁰ r, s omit. ¹⁵¹ r et qualitate; s ex quantitate. ¹⁵² r, s Non. ¹⁵³ r nisi ex.

¹⁵⁴ r, s nec. ¹⁵⁵ r nisi ex. ¹⁵⁶ v ex utrisque.

¹⁵⁷ v succutaneum. r then continues, flegma naturaliter est album, quare cutem dealbat; s flegma naturaliter cutem reddit albam.

¹⁵⁸ r, s omit. ¹⁵⁹ v cutis disposita.

¹⁶⁰ r, s omit. ¹⁶¹ r, s add, et non perfecte (profecte).

¹⁶² r attenuante coleram quiddam infra citrinitatem tinctum; s attenuate coleram quiddam habet intra citrinitatem tinctum.

¹⁶³ s cutem secundum glaucum componit colorem. ¹⁶⁴ r glauce componitur colori.

¹⁶⁵ v habundantia. ¹⁶⁶ r, s omit to virtutis.

defectu virtutis digestive ut in leucoflegmantia¹⁶⁷, in qua albus fit color ex habundantia aquosi flegmatis vel lividus sive¹⁶⁸ (v fol. 115v.) plumbeus¹⁶⁹. Ex defectu carnis¹⁷⁰ et mortificatione vel¹⁷¹ ex debilitate virtutis immutative¹⁷², ut in morphea alba¹⁷³ et nigra, cum melancolia vel flegma immutatum¹⁷⁴ immutat¹⁷⁵ cutem secundum se. Ex superhabundantia malorum humorum, ut¹⁷⁶ croceus in¹⁷⁷ icteria vel tertiana, citrinus ex colera, viridis in agiraca(?) pegasilontis¹⁷⁸, niger¹⁷⁹ in melanchirone(?).

Ex elementis autem¹⁸⁰ fiunt diversi colores vel¹⁸¹ ex eorum singularitate vel ex pluribus et diversis. Ex elementorum¹⁸² singularitate singulares¹⁸³ et simplices fiunt colores ut rubeus et¹⁸⁴ huic¹⁸⁵ similes¹⁸⁶. Nam dum ignis superhabundat in aliquo subiecto, sui caliditate¹⁸⁷ coloratur, ut in hoc igne elementato fit color¹⁸⁸ rubeus. Ex ignis superhabundantia que¹⁸⁹ non superhabundat in subiecto¹⁹⁰ ignis sed sui subtilitate circumfunditur per superficiem et eam colorans rubeum¹⁹¹ reddit colorem, ut in rosa¹⁹² rubea¹⁹³, in qua, etsi ignis non predominetur, tamen pro sui circumfusione talis¹⁹⁴ fit color.

Eodem modo ex aqua varii¹⁹⁵ secundum sui habundantiam in subiecto vel circumfusione¹⁹⁶ fiunt¹⁹⁷ colores. Secundum enim maiorem et minorem sui habundantiam fit color¹⁹⁸ albus lacteus et glaucus. In hac namque¹⁹⁹ aqua²⁰⁰ elementata, cum maxime prehabundat aqua elementum, albus fit color. In lacte vero²⁰¹ et in quibusdam aliis, etsi aqua sit²⁰² in multa quantitate, non tamen adeo et ideo color est remissior. Ex circumfusione^{202a} ipsius, ut in cepa²⁰³

¹⁶⁷ r, s omit to aquosi.

¹⁶⁸ r, s vel. ¹⁶⁹ r, s plumbeus color.

¹⁷⁰ r, s caloris et inordinatione. ¹⁷¹ r, s et. ¹⁷² r, s immutature.

¹⁷³ r, s nigra et alba. ¹⁷⁴ r, s omit. ¹⁷⁵ r, s immutet.

¹⁷⁶ r, s omit.

¹⁷⁷ v omits in icteria vel. ¹⁷⁸ r, s add, id est, quedam species ictericie.

¹⁷⁹ r, s vel niger ut.

¹⁸⁰ r, s omit. ¹⁸¹ r, s ut.

¹⁸² r, s eorum. ¹⁸³ r, s singuli.

¹⁸⁴ s omits. ¹⁸⁵ r similis huic. ¹⁸⁶ r, s similes ex igne.

¹⁸⁷ r, s calore.

¹⁸⁸ s rubeus color. ¹⁸⁹ s quando.

¹⁹⁰ r, s ignis subiecto.

¹⁹¹ r, s rubei reddit coloris. ¹⁹² s colera. ¹⁹³ v viridi.

¹⁹⁴ v fit talis.

¹⁹⁵ v varii sunt colores.

¹⁹⁶ r, s circumfluxione. ¹⁹⁷ v omits fiunt colores.

¹⁹⁸ s albus color. ¹⁹⁹ s enim. ²⁰⁰ r omits.

²⁰¹ v autem. ²⁰² s multa sit in; v sit multa in.

^{202a} r, s circumfluxione. ²⁰³ r cepe albo; s corpore albo.

alba et alio, in quibus, etsi non habundet²⁰⁴ nec²⁰⁵ dominetur, quia²⁰⁶ tamen circumfusa est²⁰⁷ per superficiem, in²⁰⁸ suo disponit colore.

Ex terra autem fit²⁰⁹ color niger sicut²¹⁰ in pipere, in²¹¹ quo licet dominetur²¹² ignis, tamen pro nimia terre habundantia niger²¹³ fit color.

Ex habundantia commixtionis eorum similiter varii²¹⁴ et²¹⁵ diversi nascuntur colores. Ex aqua enim²¹⁶ et terra fit²¹⁷ glaucus color, que est medius²¹⁸ inter album et nigrum. Nam pro terre²¹⁹ et aque habundantia neque²²⁰ albus fit ex aqua propter²²¹ terram²²² (v fol. 115r.) ut in naturali melancolico et similibus est videri, neque²²³ niger ex terra propter²²⁴ aquam.

Ex eorum similiter²²⁵ prehabundantia²²⁶ sed non equali fit color lividus sive plumbeus et fuscus²²⁷. Nam si prehabundet aqua terre, fit lividus vel plumbeus; si terra aque²²⁸, fit fuscus color ex aqua et igne pallidus²²⁹. Si aqua prehabundet et magis circumfunditur per superficiem, fit subpallidus²³⁰; si contrario, subrubeus. Ex igne et terra fit viridis, nam dum aliquid aduritur, magis fit calidum²³¹ et siccum pro ignis et terre dominio et inde fit viride.

Ex qualitatibus ab elementis (r fol. 18v.) innatis eodem modo variantur colores. Ex frigiditate namque fit²³² albus color lividus fuscus et niger, et hic discernitur in plantis et²³³ fructibus et in aliis. In lilio enim et²³⁴ rosa alba²³⁵ in qua maior est frigiditas quam in rubea et in²³⁶ similibus. Ex frigiditate humiditas²³⁷ que trahitur ad superficiem ad nutrimentum non extenuatur sed potius ignee et aeree partes inspissantur in aquosas, ex quibus fit color albus. Proinde quecumque flores vel herbe eiusdem speciei sunt²³⁸ diversi coloris, si una sit alba et alia rubea, maiorem²³⁹ calorem habet rubea, unde²⁴⁰

²⁰⁴ v prehabundet. ²⁰⁵ s sed predominetur. ²⁰⁶ r tamen quia; s quod.

²⁰⁷ s omits. ²⁰⁸ v ea disponit suo colore.

²⁰⁹ r color fit. ²¹⁰ v ut. ²¹¹ v Etsi enim ignis dominetur in eo. ²¹² r predominetur.

²¹³ r, s fit niger.

²¹⁴ r omits. ²¹⁵ s omits et diversi.

²¹⁶ v omits. ²¹⁷ v color est glaucus. ²¹⁸ r mediocris.

²¹⁹ v aque et terre: ²²⁰ s nec.

²²¹ r, s pro terra neque lividus. ²²² r, s omit to neque.

²²³ s nec. ²²⁴ r, s pro aqua.

²²⁵ r, s omit. ²²⁶ r prehabundantia scilicet.

²²⁷ r, s omit to si terra.

²²⁸ r, s et aqua. ²²⁹ r, s fit pallidus; v palidus.

²³⁰ r, s rufus vel subrufus color, then omit to Ex igne.

²³¹ r coloratur.

²³² r, s albus fit.

²³³ v et in. ²³⁴ v et in. ²³⁵ s omits several lines that follow.

²³⁶ v omits.

²³⁷ r humiditas illa.

²³⁸ r diversi coloris sunt.

²³⁹ v maiorem; r, s rubea maiorem habet calorem. ²⁴⁰ s Ideo.

rosa rubea maiorem fertur²⁴¹ habere calorem quam²⁴² alba. In fructibus similiter fit²⁴³ albus color ut in citris²⁴⁴ in quibus, etsi tres sint substantie scilicet cortex aquositas et medium (s fol. 138r.a) tamen in eis est²⁴⁵ albus²⁴⁶ color.

Pro frigiditate et humiditate²⁴⁷ ignee et aeree partes condensantur²⁴⁸ in aquosas. Ex humiditate terrestres mollicite²⁴⁹ transeunt in aquosas, ex quibus fit color²⁵⁰ albus, ut in humano corpore, quoniam ex frigiditate calor qui debet²⁵¹ calefacere ad digestionem debilitatur. Unde, cum non bona²⁵² possit fieri digestio²⁵³, generatur plurimum flegma quod²⁵⁴ reddit album colorem (v fol. 115v.). Quod si maior fuerit frigiditas, lividum facit colorem, et hic in fructibus et in humano corpore discernitur. In fructibus enim videmus, qui nascuntur in loco valde frigido et umbroso, quod multum²⁵⁵ lividi apparent. Pro maiore namque frigiditate non solum²⁵⁶ ignee et aeree partes condensantur²⁵⁷ in aquosas, sed etiam ipse aquose incipiunt in terrestres ingrossari. Unde ex aquosis et terrestribus partibus fit lividus color, ut superius diximus. In corpore²⁵⁸ humano similiter ex multa humiditate fit mortificatio, et humiditas in fontibus contenta inspissata pro aquosis et terrestribus lividum prestat colorem. Quod si multo magis fuerit immoderata, causa est nigri coloris. Ex calore autem fit color rubeus, viridis et niger, et quidam alii qui²⁵⁹ sub istis per quamdam latitudinem continentur. Ex moderato calore moderate terrestres et aquose partes²⁶⁰ resolvuntur in igneas et²⁶¹ aereas, ex quibus fit color rubeus, ut in rosa rubea, in cuius superficie est quedam calida²⁶² substantia, ex cuius calore rubeus fit color, ut etiam²⁶³ modo diximus. In corpore similiter humano, cum²⁶⁴ ex calore terrestres et aquose partes resolvantur in igneas et aereas, multus sanguis²⁶⁵ generatus est et colera ex quibus fit color rubeus.

²⁴¹ r item habet. ²⁴² r omits quam alba.

²⁴³ v est. ²⁴⁴ r citrinis.

²⁴⁵ r, s omit. ²⁴⁶ r, s color albus.

²⁴⁷ r, s add: humiditas qua nutriuntur inspissatur ab frigiditate hee.

²⁴⁸ r, s in aquosas condensantur.

²⁴⁹ v mollicante.

²⁵⁰ r, s albus color.

²⁵¹ s deberet. ²⁵² r possit fieri bona.

²⁵³ v digestio vel decoctio. ²⁵⁴ v et album reddit colorem.

²⁵⁵ s valde.

²⁵⁶ v sole. ²⁵⁷ v in aquosas condensantur.

²⁵⁸ v humano corpore.

²⁵⁹ v omits.

²⁶⁰ r omits. ²⁶¹ v omits et aereas.

²⁶² v omits.

²⁶³ v omits.

²⁶⁴ r omits.

²⁶⁵ r, s generatur sanguis.

Quod si maior fuerit calor, fit causa viridis coloris, ut in porro²⁶⁶ et marrubio discernitur, in quibus pro multo calore humiditas de qua nutriuntur aduritur, et aquose et aeree partes in igneas resolvuntur remanentibus terrestribus et superhabundantibus, pro dissolutione tenuium²⁶⁷ et liquidorum ex igne et terra fit viriditas. Quod si multo maior fuerit²⁶⁸ fit adustio, unde magis resolutis et²⁶⁹ consumptis liquidis partibus²⁷⁰ et tenuis magis superhabundant grosse et terrestres, que ex calore²⁷¹ depurantur, et ideo fit color²⁷² niger cum quadam claritate²⁷³.

Nunc²⁷⁴ autem videndum est quare magis ex saporibus rei (v fol. 116r.) natura et complexio cum substantia percipiatur²⁷⁵ quam per colores, cum color visu²⁷⁶ proprie sit perceptibilis qui subtilior est ceteris sensibus. Ad quod²⁷⁷ dicimus quod visus non nisi superficiei percipit proprietatem, unde color quo superficies disponitur non totius substantie sed superficiei tantum declarat dispositionem. Gustus autem declarat vel comprehendit substantiam, quare cum sapor gustu percipiatur, magis complexionem rei declarat et substantiam quam color. Et hec de coloribus breviter dicta sufficiant secundum Ursonem.

That our text is said at its close to be according to Urso, is not surprising, since its style, wording, and natural philosophy resemble those of his *De effectibus qualitatum*. This may be illustrated by quoting two passages from it on the effect of heat and cold upon colour.

Colorat autem calor naturaliter sic: dum calor ignis agens in substantiam terrestria resolvit in aquosa, aquosa dissolvit in aerea ac resolvit in ignea, unde ex circumfusionem ignearum partium rubeus color in subiecto praestatur, ut videtur in rosa rubea. Vel sic: dum in corpora per calorem calidi generantur humores, et spiritus eorum diffusi sunt per totum corpus, quandoque color rubeus, quandoque citrinus corpori attribuitur.

Discolorat dum consumendo ignea et aerea, ut pote subtilia, remanent aquosa et terrestria, ut pote grossiora, a quibus color discolor nascitur in subiecto, ut videtur in rosa rubea quae fumo sulphuris superposita albescit (ed. Matthaes, 1918, lines 221-230).

²⁶⁶ r, s marrubio et porro.

²⁶⁷ v tenuum.

²⁶⁸ r, s sit calor.

²⁶⁹ v omits et consumptis. ²⁷⁰ v adds consumptis.

²⁷¹ r ea. ²⁷² s calor.

²⁷³ r adds Explicit.

²⁷⁴ s Queritur quare.

²⁷⁵ v percipitur.

²⁷⁶ r, s sit proprietas. ²⁷⁷ s hoc.

Discolorat autem frigiditas naturaliter et accidentaliter colorat. Discolorat sicut videmus in hyeme, scilicet quia corporis sui volens fugere contrarium, scilicet aeris frigiditatem, cum hi, scilicet calor, humor et spiritus, quorum praesencia corpus colorabatur, reducuntur ad interiora, fit ut cutis spiritu et humiditate pauperata livescat. Item secundum minorem et maiorem intensionem frigiditatis fit alius color pallidus, frigiditate condempnante aerea in aquosa et aquosa ex parte in terrea. Unde, contradicente terrae quidem nigridine, ab aqua color albus non innascitur; et contradicente aquae albedine, a terra niger non praestatur. Sequitur ergo color medius qui lividus appellatur. Aliquando a frigiditate fit color niger sic: dum per frigiditatem aerea condempnatur in aquosa, aquosa inspissantur omnino in terrea, ita ut dominantur penitus terrestria, color niger fit in subiecto.

Colorat autem frigiditas accidentaliter sic: dum per frigiditatem fit parum constrictio et spirituum et humorum retentio, eorum praesencia fit cutis coloratior, sicut e contrario per eorum exalationem et per calorem poros aperientem fit aliquando cutis discoloratio. Vel sic: sanguis in fontibus contentus actione caloris membrorum debet dealbari, sed exterior frigiditas aliquando supervenit quae membra infrigidat. Caliditas autem intrinsecus existens eius impedit actionem circa sanguinis dealbationem, unde sanguis a colore suo non alteratur et membra secundum se colorat et cutem reddit rubeam, ut est videre in pueris per aquam frigidam transeuntibus pedibus discalciatis, quorum tibiae et pedes propter praedictas rationes rubescere videmus (*Ibid.*, line 350 *et seq.*).

These are the only passages on colours in *De effectibus qualitatum*, so that the question remains open whether Urso also wrote a separate and more extended treatment of the subject, or whether a disciple or later imitator of him elaborated upon his ideas. R. Creutz suggested that our text is also indebted to Urso's *De commixtionibus elementorum*²⁷⁸.

Our text is immediately followed in the Vienna manuscript by a discussion why peacocks have so large a tail and such varied colours²⁷⁹ in it, after which is another question why leaves differ so in shape²⁸⁰.

III

Of a work on colours by John of Bologna I know of only one manuscript: Copenhagen Gl.kgl.S.1656, 14th-15th century, fols. 170r.b-171r.b. His name does not appear in Mrs. Singer's Catalogue, while the sole mention of such a

²⁷⁸ R. Creutz, *Urso der Letzte des Hochsalerno*, Berlin, 1934, pp. 5-6.

²⁷⁹ Vienna 5207, fols. 116v.-117r.: opening, "Queritur quare pavones habeant tam magnam caudam . . .".

²⁸⁰ *Ibid.*, fol. 117r.-, "Queritur quare quedam frondes sunt longe acute . . .".

person by Corbett is "La recepte de maistre Jehan de Boulogne" (at fol. 101r. of Latin MS. 7162, 15th-16th century, of the Bibliothèque Nationale, Paris), whom Corbett identifies with an illuminator of 1451-2, a date which seems too late for the writer in Latin of the Copenhagen manuscript²⁸¹. Its text is very difficult to read in places, and a second photostatic copy has proved to be less distinct than the first. Since, however, it seems rather unique, bearing for example little or no resemblance to the texts published by Professor D. V. Thompson, Jr., in *Speculum*, I (1926), 280-307, from MS. Sloane 1754 of the British Museum, and in *Isis*, 22 (1935), 456-68, and 24 (1936), 382-96, from Latin MS. 6749B of the Bibliothèque Nationale, and Munich, cod.lat. 444, fols. 214v.a-217v.a, it may be advisable to print here as much of it as I have been able to decipher. Although John is called of Bologna, his experiments with colours are said in the colophon to have been performed at Gorlicz, which probably means Görz in Carniola rather than Görlitz in Thuringia or Koritza in Albania.

INCIPIUNT COLORES ET TEMPERATURE MAGISTRI IOHANNIS BONONIENSIS

Colorem viridem²⁸² sic prepara. Recipe favum mellis distemperatum cum aceto forti et pone in aliquo vase et sepeli in fimo per novem dies, et erit optimus color.

De colore rubeo. Colorem rubeum sic fac. Recipe presilium et rade eum cum cultello minutissime et pone in vas vitreum. Superfunde acetum vini vel urinam vel albumen ovorum, quod melius est. Commove bene, dimitte stare per noctem, et inpone tunc parum de alumine trito, et stet per horam, et cum isto operare.

De cinobrio. Ad cinobrium recipe zaybac sulphuris vivi, omnes ana tere et pone in vase vitreato per ignem lentum per unum dimidium diem, et cave ne sit fortus ignis, quia opus tuum perderes.

De ruffo Parisiensi. Rufum Parisiense sic fac. Recipe lacce partem unam, aluminis partes duas, tere optime, et sal corallatum partes octo coque sublimando et imbibendo usque ad consumptionem tercie partis et despuma et tunc funde super pulverem istum, et stet per quinque dies movendo. Tunc coque ad lentum ignem semper movendo, tunc proba in ungue vel in corio, si color tibi placeat.

²⁸¹ Corbett, *op. cit.*, p. 113. The name does not appear in Corbett's second volume, *Manuscrits des bibliothèques publiques des départements français*, 1951.

²⁸² Viridum in the MS.

De lazurio. Lazurium sic fit. Recipe duo partes aceti boni vini, decem partes aluminis; pone in vase ereo per decem. Postea ad ignem modicum calefac. Pone sub terram per quinque dies, Cum floridum fuerit, extrahe, pone ad solem donec arescat.

Item. (Recipe) item ampullam puri electri vel cupri auricalci, Inple cum calce et forti tartaro in alembico sublimato horis novem. Claude, postea pone in terram calidam, et erit bonum lazurium, cum quo habebis expensam domino deo concedente leviozem.

De viridi ere. Viride eris sic fac. Lamine irrorate lavate mercurii suspendantur in aere super vapores aceti acerrimi et ponantur in aliquod vas. Vas sit prius bene argillatum luto sapientie quod in ocluta philosophia lutum philosophorum dicitur, ne aliquo modo respirare possit. Mictatur sic stare tribus ebdomadibus vel quatuor. Postea aperi et invenies viride eris in laminis adherere quod (fol. 170v.a) acuto cultello abrades, reserva. Item suspende eas sicut prius super acetum. Ita fac donec lamine totaliter convertantur in viride eris.

De cynobrio. Quomodo debet fieri cinobrium. Recipe de argento vivo duas partes, sulphuris tres partes, hec tere et appone in vas vitreum angustum habens collum. Vas sit prius bene argillatum ad spissitudinem unius digiti qui medicus dicitur in musica. Tunc inpone medicinam. Pone super tripedem, obstrue os vasis, da ignem valde lentum per medium equinoctium. Postea vigora ignem, melius sit assa per integrum equidiem et invenies. Permicte infrigidari.

De cerusa. Recipe laminis plumbi et pone super vapores aceti. Claude ollam. Fac per omnia ut te docui in viridi eris.

De colore rubeo. Recipe cerusam, tere peroptime, quam bene trita. Fac inde quasi pastam. Pone in vas fictile formatum longitudinem habens non rotunditatem. Sed prius debes ponere ollam magnam super lapides vel super duos parietes de argilla factos in altitudinem unius spanne, et super illos parietes pone ollam illam ut os olle iaceat super unum parietem et fundus olle super alium parietem. Et tunc impone vasculum in medium olle cum cerusa. Cooperi cum alio vase coniuncto sibi. Da ignem primo lentum, postea fortiozem fere per medium diem. Tunc dimitte infrigidari et invenies cerusam iam aliquantulum rufam. Iterum tere et fac sicut prius assando per dimidium diem. Extrahe et habebis optimum minium.

*De minio*²⁸³. Minium autem de cinere plumbi fit sic. Pone ollam super parietes ut supra et impone plumbum et da ignem fortem. Cum autem plumbum liquefactum fuerit, habe cocliar longum ferreum cum quo move plumbum hinc et inde. Statim incineratur. Et da ignem fortem donec totum vertatur in pulverem, in quo infrigidato cola per pannum valde artum vel per cribrum.

²⁸³ From the margin.

Quod supra manet iterum in ollam pone semper movendo donec pulverem subtilem habeas. Cola ut prius, et quod colatum est contere super lapidem cum aqua. Et fac per omnia ut supra docui de cerusa, concutiendo et assando donec habeas valde rubeum.

(*Rubric obliterated.*) Recipe de lazurio partes duas, argenti vivi octo, partes sulphuris (fol. 170v.b) octo, salis armoniaci octo. Contere simul sicut de cinobrio. Pone in vase vitreo. Fac per omnia sicut te docui facere cinobrium.

De rosa. Recipe album Apulia. Apone ter cantum(?) presilii, et erit rosa. Tunc non est apponenda crida.

De violitis. Ad violitis. Recipe presilium blavium colorem ana. Appone parum mellis.

De scarlatico. Ad scarletum recipe de rubrica et de blavio. Commisce et erit brunetum album et lazurium. Compone et factus est color pulcher.

De griseo. Ad griseum album et nigrum compone.

De lichte. Lichte varwe album et presilium commisce ter in concha vel in cornu.

*De bruneto*²⁸⁴. Aquam calcis, cum serena est facta, funde in novam ollam. Adde lotum presilii, decoque in illa aqua. Potest recipere cridam et adde dimidium lotum lapidis calcinioris(?) bene tritum. Pone in vas purum donec non spumescat et tunc infunde cridam.

Item ad idem. Rade presilium, mecte in cornu plumbeum. Infunde novam claretam, parum rubrici aluminis. Mecte maturescere donec optime coloratum sit; stet. Parum de alumine, eo splendidior color et levior. Si autem multum, eo nigrius et tenacius. Parum distempera de isto, quia non datur nisi primo die vel secundo. Quidam cum eo tingunt modicum lazurii. Si autem album cum eo miscueris, erit pulcher color roseus. Si autem parum de albo, parum de croco, parum aluminis, et fit sanguineus color. Si in eo parum vermiculi miscueris, erit optimum brunium. Pictores periti cum omnibus fere miscent presilium.

Item. Item ad presilium funde clarum, post horam sparge alumen modicum, mecte²⁸⁵ per noctare ut spissetur. Tunc cola per pannum et operare de presilio.

Auripicmentum tere cum aqua, apone cride quantum vis et reconde. Postea tempera cum claro, apone vitellum crocum et erit optimum.

De costo. Costum sic fit. Recipe album de publica(?)²⁸⁶, appone viride eris ad . . . et bene tritine. Parum de cinobrio.

Item ad idem. Recipe lazurium cum croco bene trito, gummi vel claro, et tempera tenue et pone ad omnes colores.

²⁸⁴ De presilio, in the margin.

²⁸⁵ Micto in the MS.

²⁸⁶ *Album* of Apulia seems to be meant.

De nigro. Ad nigrum coque cervisiam et nigram sucorum equorum, quodlibet separatim, quod coquatur. Et tunc infundatur ad unam ollam; coque. Tunc attramentum tritum apponatur, parum (fol. 171r.a) mellis vel gummi arabici cum substantia . . . (?) Recipe acetum acerrimum, funde super feces, trahe limaturam ferri. Tunc conficiendes (?) bis id est (?). Hoc facto ut predictum est tempera.

(*Rubric obliterated*). Conbure sal et tere bene in lapidem. Funde et sparge super quamlibet tabulam istud sal et . . . fortissime teratur super lapidem et coque mundum pulverem. Et tunc cum aqua calcina mundissime lavetur sepe donec sal deficiat, substantia autem ibi maneat. Tempera cum gummi arabico scribens (?) cum penna et post poli dente equino.

De eodem. Item exustum aurum mercurio apposito potest scoriri (?) in mercurio posito in testa calida et si tunc cbyati (?) super lapidem temperetur cum gummi arabico.

Ad florizandum cum auro. Ad florandum aurum vel (?) argentum collige istud . . . (?) in crusibili (?) et distempera claro. Tunc recipe genus rufum cum eis et diligentur teres claro gummi distempera sciride (?) quod eciam . . . (?) vocatur. Poli cum aurea lamina vel argentea.

Ad ponendum aurum. Ad ponendum aurum super pergamenum. Recipe cridam et ocrum, tunc tere super lapidem, tempera cum claro putrido in hyeme xv diebus, estate viii. Et tunc recipe clarum putridum et tere cum crida et ocrum, et plus de crida quam de ocrum, unde stare duos dies et in tercio operare.

De eodem. Recipe cridam tritam, pone in cornu et tunc recipe crocum quem in mundum pannum pone. Tinge pannum cum croco in albumine ovi. Deprime in cornu super cridam ovium testas. Fiat crida vel aliter. Recipe tres partes de crida, quatuor de ocrum. Tere cridam subtiliter cera. Tempera eam claro ovi quod natum sit die altero [two or three illegible words] quando est bene ceratum, pone in cornu, postea mictre clarescere. Tunc cola clarum ovi et impone forte gummi arabicum duas partes et tres de claro. Tempera spissum ita quod . . . et pone succaram (?) in madido loco et illumina picturam antequam cidas aurum.

De variacione colorum. Colorem sic varia. Crocum cum claro putrido eodem in mixtum infunde modicum valde de nigro, crocum cum thema (?) et cinobrio . . . et bene crior si sit, habebis aureum colorem. Sic proba operatam. Recipe cedulam, funde parum in concham et impone cum vitello super cedulam. Ita iterum (?) et ac si esset cinobrium et (fol. 171r.b) cum siccum fuerit, tempera cum digito sicut rumpere velis (?). Si rumpitur, hoc est de fortiori (?) id est clari. Iterum impone aquam compescere fortitudinem eius et tunc iterum in pergameno tempera. Et si non rumpitur, accipe cultellum et istud, et cum siccatur et equaliter iacet, tunc pone aurum desuper et poli

cum dente lato. Et si non fuerit ter temperata, levabit se aurum cum pergameno.

De licteris aureis. Ad aureas licteras. Recipe limaturam uniuscuiusque metalli et ipso trito in mortario cum albumine ovorum et sale grosso et aceto acerrimo, croco, lava bene pulverem cum aqua, ad umbram tunc(?) sicca. Cum scribere vis, tempera cum claro in vase vitreo et tunc poli.

De eodem. Recipe vitreolum et mercurium, evacua ovum, impone eam sibi, pone sub gallinam ut excubet ova, inde fit pulvis. Istum pulverem tempera cum vino et scribe aureas literas.

Item de eodem. Ad aurum scribendum recipe sal lapidosum et tabulas auri dupliciter vel tripliciter desuper pone. Post tere bene pariter et pone in mundum cornu. Lava sal, inde fac liqueum(?) lictinum esoces(?). Parum commisce cum claro ovi, funde super aurum, scribe quod velis.

De cinobrio putrefacto. Cum cinobrium fuerit putridum, tere alumen, move cum ceciderit, depono spuma(m) aluminis, et reformabis.

Expliciunt illuminationes et temperature colorum compositiones magistri Iohannis Bononiensis expertas (sic) in Gorlicz.

IV

De colorum diversitate tractatus in Palatine Latin MS. 1339, fols. 141r.-143v., at the Vatican, is in large part identical with the *Tractatus de coloribus* which Professor Daniel V. Thompson Jr., published from Latin MS. 6749B of the Bibliothèque Nationale at Paris, fols. 61r.-62v., in *Isis*, 22 (1935), 456-68, and Latin MS. 444 of the Staatsbibliothek, Munich, fols. 214v.-217v.a, *Ibid.*, 24 (1937), 382-96. In the Vatican MS. the work opens:

De colorum diversitate tractatus incipit Qualiter quilibet color artificialiter fieri possit atque duplari debeat . . .

In the Paris MS. it begins:

Tractatus qualiter quilibet artificialis color fieri possit atque dupplari . . .

The two MSS. are then roughly identical until, on fol. 142r., Palat. 1339 treats *De rosa*, which does not seem to occur in either of Thompson's MSS. Until then there are only minor variations between the two texts, such as *lazurium inframarinum* of Palat. 1339 instead of *citramarinum*²⁸⁷.

²⁸⁷ Some other variants are *terrea* for *ferrea* (*Isis*, 22, 460, line 6); *colorem pallidum* for *palorem* (line 10); *de alumine glasse* for *de allumini glacie* (line 13); *dimidiam* for *i* (line 17); *primo* for *postea* (line 20); *et ture* for *tunc* (line 21); *reserva* for *serva* (line 24); *una* for *ii* (461, 2); *reperies* for *invenies* (462, 7); *redacta* for *resolutam* (463, 4); *manu tua* for *mannubriam* (463, 9); *currat* for *erant* (463, 11); *avenam* for *arenam* (463, 19); *peccatum* for *p<er>-itium* (463, 20); *quodam* for *quodem* (463, 21); *marmoris albi* for *marmorum* (465, 2); *doliis* for *testis* and *totum informa* for *trossiscas in forma* (465, 3); *utere* for *utari* (465, 5); *vegete* for *laguna* (465, 8).

After the *De rosa* passage, at the top of fol. 142v. comes a paragraph on vermilion which corresponds to the first part of *De modo componendi vermillionem* in C.L.M. 444 (*Isis*, **24**, 1936, 386). But the next paragraph, *Quomodo fiat carminum id est synopide* seems not in the Paris and Munich MSS. The next two paragraphs on verdigris are, however, also found in C.L.M. 444 (*Isis*, **24**, 1936, 393), while those on ceruse, minium and aureus Lombardicus on fol. 143r., occur in the Paris MS., albeit in a different order (*Isis*, **22**, 1935, 466-7). *Pulvis aureus* seems peculiar to Palat. 1339, but its paragraphs on varnish (*vernisa*) are matched by C.L.M. 444 (*Isis*, **24**, 1936, 394-5). Its next two paragraphs are in reverse order in C.L.M. 444 and in sufficiently variant form to justify repeating them in parallel columns. Its closing passage on how to convert lead and tin into quicksilver is not in the other two texts on colours.

I now give those parts of *De diversitate colorum* which are not included in the other two MSS. as reproduced by Thompson, and in parallel columns the comparison of one bit of its text with that in C.L.M. 444. Of the three MSS. C.L.M. 444 presents the fullest text, and B.N. 6749B the most abridged. Palat. 1339 lies in between.

De rosa

Modo videndum est qualiter fit rosa id est color roseus valde pulcher. Accipe terram pellicariam in qua fac foramen latum et aliquantulum profundum in quo sit pannum vel sericum in quo sit pulvis terre pellicarie vel calx vitri vel marmoris vel album de Apulia cum aliquantulo aluminis glasse et superfunde plurimum predicto decoctione brasileti tot vicibus inbibendo vel etiam colando donec sufficit.

Decoctum brasileti hoc modo fit. Accipe bonum brasiletum subtilissime rasum et ipsum bullire permittre aliquantulum in aqua pura vel in lexivio bono et claro. Post colabe per pannum lineum livorem bene extorquendo de quo liquore inbibe pulverem colore roseo colorando.

Quod si volueris scribere literam roseam valde pulchram, rade brasiletum in concha vitrea vel in cornu tuo et superfunde ovorum glaream bene cum baculo movendo. Postea appone aliquantulum aluminis conglasse(?) et idem move bene et cola per pannum et scribe veld'de incausto literam roseam valde pulchram (fol. 142v.).

Quo modo fiat carminum id est synopide. Accipe urinam bonam et longo tempore generatam et ipsam a fecibus depuratam decoque donec medietas ipsius sit consumpta et optime depurata et despumata quanta(?) sit decocta inpone laccam in subtilissimum pulverem redactam et ponere per horam modicam lento igne donec lacca fundatur et dissolvatur diligenter movendo, ne crematur. Post cola per pannum lineum et reserva in patella terrea. Post accipe de alumine glasse quartam partem respectu lacce et dissolve in aqua tepida. Post infunde paulatim aluminis decoctionem in ipsam laccam et

congelabitur ad modum lactis. Hoc facto habeas sacculum lineum inferius strictum in quo pone iam dictam decoctionem et colabitur in ipsa urina ad modum aque clare qua ex toto distillata collige colorem trociskas parvulas informando quas ad umbram mansuete²⁸⁸ desiccari permitte et utere. De fecibus vero que in prima decoctione remanserunt poteris facere secundum colorem grossum in muris et valde tere hoc modo. Tere ipsas minutissime. Post bullire permitte in aqua pura cum brasileto per horam. Post impone pulverem aluminis glasse pillulas informando. Desicca ut prius.

Pulvis aureus hoc modo conficitur qui valet in muris et in tabulis altiorum et in ymaginibus. Accipe dragma i argenti vivi et dragma salis armoniaci et dragma i alu. plu. fuso primo sulfure in testa quo fuso at ab igne deposito impone argentum vivum deinde sal et alumen. Post pone totum in ampulla vitrea quam loca inter cineres calidas et decoque ad modum vermilionis et habebis pulverem aureum bonum.

VATIC. PALAT. LAT. 1339.

Nunc videndum est qualiter fiat color niger visui; cum tamen de ipso illuminantur pocule argenteae vel stanee, inducit colorem aureum valde pulchrum, et fit in hunc modum. Accipe lb. vel dragma de glassa vel dragmas ii de aloe vel aloe caballino, que in pulverem redacta ponatur in potto interius bene plumbato, et superpone alium pottum in fundo foramen habentem, et dissolve ad ignem ut iam dictum est de vernisa. Post oleum infunde bene calidum diligenter cum spatula incorporando atque movendo. Post cola per pannum lineum.

Si vis deaurare pellas, laminas argenteas vel stagneas, accipe fel bovinum in quo dissolve argentum(?). Post vitello in ipso intincto illinias tabulas iam dictas. Postea desiccari permitte. Idem fieri poterit de vernisa.

C.L.M. 444.

Nunc dicendum est qualiter fiat tenta que est color miser visu; cum tamen de ipso liniuntur scutelle argenteae vel stagnee, inducit colorem aureum valde pulchrum. Et fit in hunc modum. Accipe libram i de glassa pulverizata et libram i et dimidiam de aloe caballino; que in pulverem redacta pone in vase aliquo interius bene plumbato, cui superpone aliud vas in fundo foramen habente (*sic*), et dissolve ad ignem ut supra dictum est de vernisa. Post oleum infunde bene calidum semper cum spatula incorporando, atque modo post proba et cola per pannum lineum.

Si vis deaurare pelles aut laminas, recipe fel bovinum in quo dissolve crocum ytalicum. Post superpone ipsis prius cum aliquo planatino bene planatis, et cetera.

²⁸⁸ MS. maslere.

Qualiter plumbum vel stagnum converti possit in argentum vivum. Accipe plumbum et ipsum funde in crusibulo quo fuso ab igne deposito pondere(?) sui argenti vivi pulverizetur et incorporetur de aqua salis armoniaci atque tartari et de sale urine vel de sale communi tantum et pone in ampulla vitrea bene opturata quam loca(?) sub fimo calido et humido per dies xviii vel amplius ut ibi resolvatur et in argentum vivum convertatur.

V

A 16th-century manuscript at Milan, Ambros. D. inf. 290, offers a very different text from those with which we have thus far dealt. It is simply a compilation of everything that its writer could find in Pliny and other ancient classical authors regarding colours, and fills nearly a hundred leaves. Apparently nothing from the long intervening period is thought worthy of notice. This typical product of the so-called Italian renaissance or classical reaction makes one concession, however, to the present. All the long array of names and citations—there is an alphabetical index at fols. 1r.a-IIIv.b—²⁸⁹ are grouped under a few vernacular words for colours: bianco, fols. 1r.-6r.; negro, 7r.-11v.; rosso, 13r.-45v. and 46v.; giallo, 49r.-74v.; azzuro, 77r.-82v.; verde, 85r.-91r. From this it would appear that the author of the compilation expected it to be of some practical service. The remaining contents are unclassified:

89r.	Batrachium color (colour of frogs).
89v.	Vitreus color.
90r.	Hederatius color.
93r.-v.	Vario colore.
97r.-99v.	Some notes on colours.
100v.	A list of a few beginning with Zanolino di Murano.

²⁸⁹ Fols. IV, V, and VI are blank; the text occupies fols. 1r.-100v. under arabic numerals.

ON A 16TH CENTURY CARTOON CONCERNING THE DEVILISH WEAPON OF GUNPOWDER:

SOME MEDIEVAL REACTIONS TO GUNS AND GUNPOWDER

BY DOROTHEA WALEY SINGER

INTRODUCTION. I. MYTHS OF DISCOVERY OF GUNPOWDER BY MONKS AND OF DEMONS' INSPIRATION

THE introduction of artillery with increasingly powerful propulsion by the force of gunpowder, aroused in late medieval times, and even in the 16th century, feelings somewhat analogous to those caused by the advent of nuclear weapons in our own day.

A persistent myth that lasted to the 19th century, regarded gunpowder as the invention of monks through the inspiration of demons. One source of this myth may well have been the fact that throughout the medieval period, technological crafts were pursued and often notably improved in monastic establishments, especially those of the Cistercians; and in the medieval period there was but a hazy distinction in the popular mind between knowledge or skill, and magic. Later times attributed the discovery of gunpowder to Roger Bacon, on the strength of a passage in a work now known not to be from his pen: nor need we consider here the similar claim made for Albertus Magnus, based on certain recipes in the *De mirabilibus mundi* which Thorndike has shown to be pseudonymous. But the myth of monastic discovery of gunpowder, with the assistance of devils, was associated more widely and persistently with a figure who, perhaps, never existed, Berthold Schwarz—or Bertholdus Niger. We may cite the comment of Sarton on this claim:

Bertholdus Niger legendary inventor of gunpowder and firearms. There is no agreement among the many data concerning him. . . . Was he a Cistercian monk, or Franciscan, who flourished in Freiburg-im-Breisgau in the 13th or 14th century; was his original name Constantin Angklitzen?¹ In a 15th-century document, he is called "*Ein Meister aus Kriechenland*" which exemplifies the lasting fame of the Greek Marcus Grecus (13th, second half)². He is credited with the invention of gunpowder . . . and it is said he was executed in 1388 because of it. By that time, however, gunpowder had long been in use³.

¹ Cf. *infra*, p. 27.

² Cf. *infra*, p. 30.

³ George Sarton, *Introduction to the History of Science* (3 vols. in 5), Baltimore, 1927-48, I, 494; II, ii, 1036-8; III, ii, 725 *sqq.*; IV, ii, 1058-60.

Some texts suggest that the discovery of gunpowder was accidental, and they often show a grinning devil or satan watching the terrifying explosion from behind. It is remarkable that many of those entrusted with the duty of manufacturing gunpowder use language that might be expected rather from its victims, concerning its "satanic powers". We will turn to our illustration of this conception of devilish participation.

2. 16TH CENTURY CARTOON CONCERNING GUNPOWDER AND GUNS

The illustration facing page 26 is reproduced from a tinted drawing, of about the middle of the 16th century, inserted in a parchment manuscript of the 15th century⁴. It will be seen that no names are mentioned. The artist, a vehement Protestant, expresses the myth that gunpowder, with its use in guns, was the invention of monks prompted by demons. The upper part of the cartoon shows a bearded religious, striding along bearing a cross in his left and a staff in his right hand. Above him is the distich:

Hic falso reserat fores supernas
Et peccata pecunia remittit.

(He fraudulently opens the gates of heaven, and for pelf he remitteth sins.)

Below the figure we read the exclamation in English:

Harke now I here a voise of Cankerish supersticion
When Murkish sect to demon, like if full of Indignacion⁵.

Beneath this, is the tinted representation of two religious each embraced by a grinning horned demon, and separated by a gun on a two-wheeled vehicle. The monk on the right holds the gun, and his demon wields a ramrod. The monk on the left, with his demon, is making a mixture in a cylindrical vessel—which rests on a large circular object. Below, on the ground, are two small wide bowls full of round objects, presumably cannon balls. Into that on the left, a large rat pushes two ramrods. At the bottom of the page, underneath this picture, is written:

Neare aboute anno 1378 was browght to passe the fuller makeng of gunne-
pouder as Reporteth the Swisers Cronicle; Be sertayne of the Religius.
No name sertaineli knowen of the Inventor.

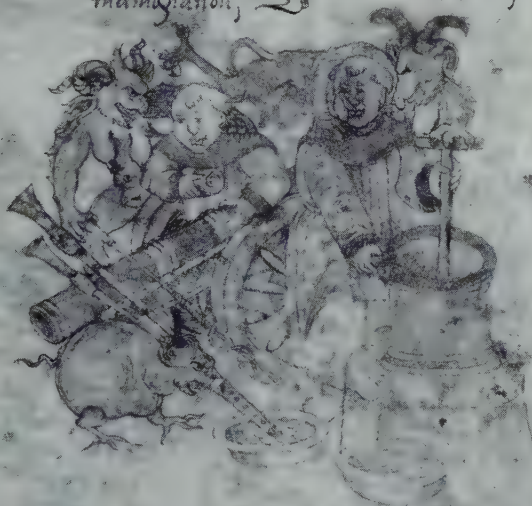
⁴ See Appendix, p. 33.

⁵ Miss Taylor (see p. 33) suggests that the meaning of these lines may be that the religious dubbed "murkish sect" are full of indignation at being taught and helped by demons, when they don't require it!

Hic falso refert fores superanas
Et peccata pecunia remittit



Marke now I here advise of Cawkerd supersticio
When Murrish put to demon like if full of
indimagination, &c



Neare aboute y^e 1378 was brought to passe y^e full making
of gunpowder as Reporte y^e w^{ch} d^e Countie Be certayne of
Rengius No name certaintie knowen of y^e inventor &c

3. OTHER COMPARABLE ILLUSTRATIONS

A collection of reproductions of early illustrations connected with gunpowder and guns, was published by the military engineer Oscar Guttman⁶. He found no fewer than twelve figures supposed to represent Berthold Schwarz, often with demon attendants, beginning with a repulsive caricature in the *Schweyzer Chronik* published by Johann Stumpf in 1554, and closing with the monument raised to Schwarz by the pride of his supposed fellow-citizens of Freiburg-im-Breisgau late in the 19th century. A monk in terrified retreat from an explosion, with grinning satanic figure or figures in the background, may almost be described as the signature symbol of the mythical Berthold Schwarz. Unpleasant hog-like creatures are often included in the illustrations.

The figure of Berthold haunts the most diverse works, through many centuries. For example, the French traveller and geographer, André Thevet (1502-90), in a work on world celebrities, devotes a whole chapter to Berthold, preceded by a full-page alleged portrait (without the usual satanic suite) expressing both awe and repulsion at the terrible new weapon⁷. Again, Berthold appears in a large figure in a work on gunpowder and weapons, dedicated in 1598 to the King of France, by Joseph Boillot. Berthold kneels, holding weights and scales; various alchemical or chemical apparatus lie strewn around him; a full-size grinning devil stands behind, complete with horns, wings and cloven feet, his hand on the monk's shoulder. Boillot was in charge of the royal gunpowder factory at Langres, so we are not surprised to read his lengthy text on the importance of gunpowder and ballistics for the safety of the realm of France; and instructions how to make gunpowder, with further illustrations⁸.

We have encountered an anonymous work entitled *Berthold Schwarz der Pulver Erfinder* (*Schluss Stuck zu Fausts Leben, Thaten und Hollenfarth*)⁹, which was published in Mainz and Hamburg in 1801. It is strongly Protestant, and inveighs against the Inquisition, the Crusades, and especially against the Mendicant Orders. The work bestows on Berthold a father of noble birth, anxious to acknowledge and train his son, but foiled by the greed of the Abbot Beda of the monastery of St. Blasius in the Black Forest, to whom he had been entrusted. Berthold, it says, was called Konstantin Angklitzen.

There is yet another name advanced for the dubious honour of having invented gunpowder. This was Jean Tilleri, who is cited by Noel Taillepier in

⁶ Oscar Guttman, *Monumenta Pulveris Pyrii*, London, 1906.

⁷ André Thevet, *Pourtraits et Vies des hommes illustres Grecs, Latins, et Payens* . . . , 2 vols., Paris, 1524. Liv. VI, Chap. 93.

⁸ Joseph Boillot de Langres, *Modelles, Artifices de Feu et diverses Instruments de Guerre*, Chraumont, 1598.

⁹ There is a copy in the British Museum, pressmark: 10707.aaa.34.

Recueil d'Antiquités, Paris, 1584, as having discovered gunpowder in 1384, and thereby given the name to artillery—art of Tilleri.

Doubtless there remain to be discovered in medieval as well as later literature, other tributes to the mythical Schwarz; and also other claimants to the invention. The latest upholder of Schwarz is probably Heinrich Hansjakob, whose work: *Der Schwarze Berthold, der Erfinder des Schiesspulvers und der Feuerwaffen*, was published at Freiburg in 1891. He states that his book was written at the suggestion of the chief Burgomeister of the town. It was stimulated by the plans for the Schwarz monument, which was erected in 1892¹⁰.

4. MILITARY APPLICATION OF GUNPOWDER IN EUROPE

A word may be added here as to the earliest use of guns. Professor Forbes has pointed out that by 1250 there was a bell-foundry in Lübeck, and that the experience gained from it was important when the first bronze cannon and cannon-balls were cast in the following century¹¹.

John Barbour, Archdeacon of Aberdeen (who, however, was born only in 1321), in a metrical life of Robert the Bruce, speaks of "Gynis [i.e. guns] for Crakkis" used in 1319 at the siege of Berwick¹². It is believed that Edward III used guns against the Scots in 1327. Certainly this monarch included the cost of gunners in his record of expenses between 1344 and 1347¹³, and used them in the siege of Calais in 1346-7, though it seems not certain that they had any part in the battle of Crécy. A. R. Hall finds mention of cannon used against Metz in 1324, and against Florence in 1326¹⁴. They were probably used by the Moors in Andalusia, at Baza in 1325, Martos in 1326, and Alicante in 1331 (*cf.* § 5, p. 30). Sarton meditates whether they were used by German knights at the siege of Cividade del Friuli in 1331, and by Alfonso XI of Castile against Algeciras. Guns are represented in frescoes painted in 1340 by Paolo Neri for the monastery of Lecetto, near Siena, and we may recall that Petrarch mentions guns in the *De remediis utriusque fortunae* 1358-60.

All authorities appear to agree that the earliest representation of any sort of gun is in the MS. XCII of Christ Church College, Oxford, in the "De

¹⁰ Much further material concerning the Berthold myth will be found in Oscar Guttman, *op. cit.*

¹¹ R. F. Forbes, *Metallurgy in History of Technology*, ed. by Charles Singer, E. J. Holmyard, A. R. Hall, and T. Williams, Oxford (5 vols.), 1950-8, II, 64, 1956.

¹² R. Coltman Clepham, *Outline of the History of Gunpowder and that of the Hand-Gun from the epoch of the earliest records to the end of the XVth century*, in *Archaeological Journal*, Vol. LXVI, 1909 (i.e. Second Series, Vol. XVI), pp. 145-70.

¹³ H. Spelman, *Glossarium Archaeologicum*, London, 1626 and 1644.

¹⁴ A. R. Hall, *Note on military Pyrotechnics in History of Technology, op. cit.*, II, 726.

officiis regum" written in 1327 by Walter de Millemete, who was Prebendary of the Collegiate Church of Glaseney in Cornwall, and was chaplain to Edward III. This figure has often been reproduced, and Sarton explains that it represented the earliest type of cannon called *Vasi* by the Italians, and *pots de fer* by the French. I have not seen the original, but Clepham mentions that the manuscript contains a great number of illustrations, one showing an armed soldier about to discharge a cannon at the gate of a castle.

Many documents are cited showing the use of guns by French armies in the second half of the 14th century¹⁵. As regards Germany, Lalanne, who gives a mine of interesting and well-documented information, points out the early mention of *Katzen* and *Büchsen* as small mortars, and of the *Katzenstadt* or gun-factory at Augsburg in the 14th century¹⁶. A. R. Hall has also interesting notes on development in the construction of guns, and recalls that the *Feuerwerksbuch* of 1427 has interesting information on this subject.

The 15th and succeeding centuries provide many works of "master gunners", from the well-known work of Konrad Kyeser of Eichstatt, of 1405, to that of Nathaniel Nye of Worcester—1647.

Turning to the 16th century, we may note a series of engravings executed by members of the Flemish family De Galle, in Antwerp, from drawings sent from Florence by the Flemish artist Jan van der Straet (Stradanus, 1523-1605), and entitled *Nova Reperta* (New Discoveries). In this series, is one inscribed (in some versions):

Pulvis pyrius.
Manu quali tonitruum atque fulmina
Datum videtur inferis ab invidis.

(Gunpowder. Thunder and lightning made by hand. It seems to be a gift from the jealous underworld.)

This very complex work shows the art of casting guns, carried out by a number of workmen under the supervision of a finely dressed master. Iron is fed into the furnace from which flows a stream of molten metal. A cannon is being manufactured, the lathe worked by a human tread-wheel. On the other side of the picture, the cannon is being completed, and around it lie cannon-balls; other tools lie to hand. Above, through a window, we see a fortified city which is falling to an attack by gunfire. A small vignette, in the upper

¹⁵ L. Lacabane, *De la poudre à canon et de son introduction en France au XIV siècle*, in *Bibliothèque de l'Ecole des Chartes*, Série II, Tome 1, Paris, 1844, pp. 28-57.

¹⁶ L. Lalanne, *Essai sur le feu grégeois et sur l'introduction en France de la poudre à canon en Europe et principalement en France*, in *Mémoires présentées par divers savants de l'Académie Royal des Inscriptions et Belles Lettres de l'Institut de France*, Paris, 1843, pp. 294-362.

centre, shows a monk surrounded by chemical apparatus; and soaring flames have burst open the lid of a vessel by his side¹⁷.

5. GREEK FIRE AND EXPLOSIVES IN NON-EUROPEAN LANDS, AND THEIR TRANSMISSION TO EUROPE

We have discussed traditions concerning gunpowder as a European invention. Dr. Joseph Needham¹⁸ finds that gunpowder was discovered by the Chinese and that: "among the causes of the fragmentation of China in the 10th century were the new forms of warfare, especially the use of gunpowder, the first reference to which may take us back to the beginning of the partition of China (that is about A.D. 919)".

Again, Needham reports that science and technology were active under the Sung Dynasty—the Northern Sung, 960–1126, was overrun (by the Chin) and subsequently the Southern Sung was established, 1127–1279. Moreover, he has evidence that chemistry was previously practiced in Than and Taoist temples where the manufacture of gunpowder was discovered, used, and had its proving ground in the Chin-Sung wars of the 12th century. But explosive grenades were in use by 1000, and by 1040 the work *Wie Ching Tzang Yao* had stabilized the Chinese name for gunpowder. Needham states that though East Asian scientific conceptions did not filter to Europe, East Asian technology did do so, perhaps through Mongols and others in Central Asia. He suggests that it may be possible to draw up a chart of gunpowder, as has been done for knowledge of printing and paper-making.

Conveyance of knowledge from the Far East to Western Europe, at once brings Constantinople to mind. The explosive grenades (incendiary bomb) just mentioned remind us that "Greek Fire" was merely used for incendiary purposes, and that the essential purpose of *gunpowder* was for the propulsion of a charge by the force of gunpowder from a gun. Nevertheless, Lalanne is certain that gunpowder was indispensable for *feu grégeois*, or Greek fire. Sarton found Berthold described in a 14th-century manuscript as "ein Meister aus Kriechenland" (i.e. Greece), obviously prompted by memory of Marcus Grecus, author of *Liber ignium ad comburendos hostes*. He considers that Greek fire does *not* always contain saltpetre, and points out that there has often been confusion between Greek fire and true gunpowder, of which a necessary component is saltpetre. Sarton mentions Kallinikos of Heliopolis in Syria, who

¹⁷ cf. Bern Dibner, *New Discoveries of Stradanus: Sciences, Inventions and Discoveries of the Middle Ages and the Renaissance, as represented in 24 engravings issued in the early 1580's by Stradanus*, with Introduction, Burndy Library, Newark, Connecticut.

¹⁸ Joseph Needham, *Science and Civilization in China* (in progress), Cambridge, Vol. I, 1954, pp. 4, 131, 134.

lived around 673, an architect to whom Byzantine Chronicles ascribe the invention of *feu grégeois*, said to have been first used at the siege of Constantinople in 673, when the Moslem fleet was fired by its means.

Clepham states that the brilliant 12th to 13th-century Byzantine princess Anna Commena, in her work *The Alexiad*, commemorating her imperial father, mentions tubes of bronze used in warfare. But Clepham points out that they were, in fact, "hand-guns", since they discharged no true projectile, their purpose being solely incendiary.

It would seem not improbable that the secret of gunpowder should have spread from Greeks to Moslems, and thence to Spain and Italy. A good case is made for such a probability by both Lalanne and Lacabane. The latter cites allusions to such firearms in other parts of Italy, from 1326 onwards. This Arab link may explain another claimant to the terrible invention, this time from Spain. His name is Ferrarius, and he is said by Clepham to describe his discovery in a letter to one Anselm, contained in a manuscript in the Bodleian¹⁹.

6. EARLY ATTEMPTS TO APPLY GUNPOWDER FOR PEACEFUL PURPOSES

It is pleasant to turn from the destructive force of these terrible weapons, to an attempt to use gunpowder for human welfare. We may, perhaps, take comfort from the realization that it was many centuries before gunpowder stimulated such efforts; whereas less than twenty years from the invention of the yet more horrible nuclear weapons, has seen world-wide attempt to utilize their power for human benefit.

The pioneer as regards gunpowder was the great Dutchman, Christian Huygens (1629-95). In 1666, he suggested to Colbert that the French Academy should endeavour to stimulate invention to use the force of gunpowder to raise water. He himself sought in 1673 to devise an explosion which should produce a vacuum in a tube that would then serve to conduct the water upwards. He described this in detail with illustrations in a letter written to his brother Lodewijk from Paris on 22 September, 1673²⁰. The machine did not, in fact, produce the necessary vacuum in the tube. This was achieved by Denis Papin in 1690 by a different method, not using gunpowder. There was an

¹⁹ Lynn Thorndike, *History of Magic and Experimental Science* (8 vols., 1923-58), II, New York, 1923, p. 758, speculates as to whether Ferrarius may be a corrupt form of the name of the Hebrew writer Faragut, or whether he may be the 12th-century medical writer whom de Renzi regards as Salernitan (De Renzi, *Collectio Salernitana*, 1852-9, I, 363 and 369). Again, Thorndike recalls the Frater Ferrarius whose alchemical tract addressed to the Pope, is in the early 15th century MS. Digby 164 in the Bodleian Library.

²⁰ Chr. Huygens, *Oeuvres complètes* (National Edition), The Hague, Tom. 22, 1950, pp. 241-2.

interesting anonymous comment on the effort of Huygens, published in 1687 in a French journal—written, it seems, in reply to a letter from Huygens concerning his gunpowder machine, on 24 June, 1686²¹. The French article is entitled *Ad maiorem gloriam Dei*, and runs somewhat as follows²²:

To researchers is proposed a fundamental reflection on the propulsive powers of gunpowder, and there is entrusted to their talent for investigation the power to divert the vast force of the powder to healthier applications than those hitherto known. Only irreverent thought can deny so obvious a truth, as it is God's intention that solely beneficial applications and uses should be made of all that is created, and all that is made therefrom. Everything exists only for the welfare of mankind, if they have but serious will to that end. Nevertheless, it is indeed only too well-known that in countless cases, corrupted and misled human spirit fails to strive towards such application. Such misuse has caused some to designate the discoverer of gunpowder as a magician in monk's garb, instructed by Satan; for it seems (to them) impossible to make any use of its violent power except for explosions, destruction of blasing, and annihilation. Doubtless in pre-rational days, there was similar judgment concerning the driving force of wind and of water, before these were utilized for service to the human race, when intelligent and industrious craftsmen applied them to smooth, and later to toothed wheels. The above mentioned view of the satanic origin of gunpowder, should therefore be set aside and replaced as follows:

- (1) The inventor of gunpowder, whoever he was, was a capable chemist.
- (2) The skilful achievements of chemistry are hated neither by God nor by nature, nor are they directed against God's will; since they can instantly convert active poisons into blessed means of healing.
- (3) It is possible by means of some form of control to force the aforesaid propulsive power of gunpowder, however sudden and violent it may now be, into ordered channels, so that in accordance with the function desired, it may be adapted to drive an ordinary mill or for performing other work; and this goal may be attained by earnest prayer for divine support, enthusiastic pyro-mechanical labours, and if mind and hand are ceaselessly busied with this work. . . .

²¹ *Ibid.*, Tom. 7, 1947, pp. 356–8.

²² *Nouvelles de la République des Lettres*, 1687, pp. 516–23. I have not been able to see the original of the anonymous article in this journal, which is in the British Museum Newspaper Dept., at Hendon. The article is published, in full, in F. Klemm's *Technik: eine Geschichte ihr Probleme*, Munich (2nd ed., 1957), of which an English translation by myself, with the kind technical assistance of Mr. F. W. Kent, is to appear from Messrs. Allen & Unwin early in 1959.

ACKNOWLEDGMENTS

I would like to express my warm thanks to Miss M. V. Taylor, C.B.E., who has been good enough to examine and refresh my memory of this drawing, of which the photograph was taken for me some twenty-five years ago, from the original in the Bodleian Library. It has, I think, never before been reproduced.

I thank the Bodleian Library for permission for the reproduction in this article of the illustration from a Bodleian manuscript (*see* Appendix).

APPENDIX

Note on the manuscript from which our illustration is reproduced, Oxford Bodleian Library, MS. Bodley 181 (now numbered 2081). The 16th-century drawing is interpolated in a parchment 15th-century volume containing on fols. 1-97v a copy of *Liber de Regimine principum*, composed shortly before 1284 by Giles of Rome (Aegidius Romanus), the Italian philosopher and theologian, for the benefit of his pupil the future French king, Philip IV the Handsome (1268-1314,—ascended the throne in 1285). Giles himself was a pupil of Thomas Aquinas; born about 1247, he joined the Order of Augustinian Hermits, became Head of the Order in 1292, Archbishop of Bourges in 1295, and died in 1316. A great many manuscripts exist of his numerous works on philosophy (anti-Averroism), comments on Aristotle, and on physics, astronomy, and medicine.

So strong were our artist's anti-clerical feelings that he interpolated his "cartoon" across the end of the work on fol. 97v of the manuscript. To make it clearer, we have suppressed the last lines of the 15th-century script. There follows on the next folio the work known as the *Secretum Secretorum*, long supposed to have been written by Aristotle for the benefit of his pupil Alexander the Great²³; next is a brief medical work, *Regimen Corporale*, and finally another pseudo-Aristotelian composition, *De Pomo*. All the texts, except those of our illustration, are executed in the same 15th-century English hand, and all of them very widely known in both the 14th and 15th centuries. The volume belonged in 1588-9 to Sir Robert Cotton, and a note in the hand of Sir Thomas Bodley runs: "Donum Roberti Treswel alias Somerset". The gift is thought to date from c. 1612.

²³ Edited with full notes by R. R. Steele, *Fasc. V of Opera Hactenus inedita Rogeri Baconis*, Oxford, 1920.

UNCATALOGUED TEXTS IN MS. ALL SOULS COLLEGE 81, OXFORD

BY LYNN THORNDIKE*

ALL Souls 81, a manuscript mainly of the 15th century, was so insufficiently catalogued in Coxe's catalogue of the manuscripts in Oxford colleges¹ that further description of portions of it seems in order, although some note of it has since been taken in such works as my *History of Magic and Experimental Science*², *Catalogue of Incipits*³, and Mrs. Singer's catalogue of alchemical manuscripts⁴.

Since the first eight leaves are missing, Coxe's first entry is: *Praescripta medicinale. Angl. Lat. fol. 9.* This vague caption hides the fact that at fols. 11r.-13v. is a list of waters, beginning with *aqua vitae*, which otherwise might well have been indicated in Mrs. Singer's catalogue⁵. We have "Aqua vite: prima simplex, secunda composita, tertia perfectissima." Simple *aqua vitae* is that which is made from wine without admixture of any other liquor and is called *Anima vini*; and as the soul is purer than the body, so that water is purer than wine. So that water is used in place of natural balsam, and hence the ancient philosophers called it second balsam which has all the virtues of balsam. Composite *aqua vitae* is the water which is compounded from herbs mixed with wine. That is called most perfect water which should be made in this way. (Numerous spices and herbs are listed as ingredients.) And the first water drawn off is the best; the second is good for cleansing wounds and ulcers; the third is worthless.

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¹ H. O. Coxe, *Catalogus codicum manuscriptorum qui in collegiis aulisque Oxoniensibus hodie adservantur*, 2 vols., Oxford, 1852.

² See the Indexes of Manuscripts in Vols. II, III, and IV, while in Vol. I there should have been a reference to p. 715.

³ Lynn Thorndike and Pearl Kibre: *A Catalogue of Incipits of Mediaeval Scientific Writings in Latin*, 1937.

⁴ Dorothy Waley Singer, *Catalogue of Latin and Vernacular Alchemical Manuscripts in Great Britain and Ireland dating from before the XVI Century*, 3 vols., 1928-31.

⁵ This is, of course, a counsel of perfection. One would need to go through many collections of innumerable recipes in order to find such items. For example, in the case of MS. Laud. Misc. 682, at the Bodleian, Mrs. Singer's catalogue lists the *De proprietatibus rerum* of Bartholomaeus Anglicus at fols. 99v.-182v., but omits the surgery (so called) of Milo at fols. 11r.-70v., *Incipit chirurgia fratris Milonis*. But this text is actually little more than a collection of recipes, including at fol. 24v., *Sublimatio arsenici*, and at 25r., *Ad faciendum aquam corrosivam*. Or in Sloane 2995, at the British Museum, a MS. not used in the Singer catalogue, we find at fols. 18v.a-20v.b, nine waters opening, *Prima aqua que vocatur mater balsami sic fit*. . . .

Our manuscript goes on to treat of the following waters, in some cases very briefly:

- fol. 11v., Aqua vite composita
 Aqua ardens perfectissima
 Aqua preciosa et experta ad visum clarificandum
 Ad aquam egregiam componendam que valet ad omnes infirmitates oculorum
 Aqua aromatica ad ornatum facierum dominorum et dominarum
- 12r., Aqua lac virginis valet ad scabiem et salsum fleumam in tibiis
 Aqua tartari et dealbat pellem
 Aqua salis gemme
 Aqua mirabilis cum qua facit medicus mirabilia sive mistica, nam si quis cum ea operetur, cicius dicetur propheta quam medicus
- 12v., Aqua mellis, valet ad capillos restaurandos
 Aqua rosacea
 Aqua optima ad visum clarificandum
 Aqua nenufarina
 Aqua de floribus caprifolii
 Aqua plantaginis
 Aqua de virgulis coruli
- 13r., Aqua erbfrase(?)
 Aqua celidonis
 Aqua Iovis barbe
 Aqua florum fabarum
 Aqua de seminibus herbarum
 Unguentum expertum ad omnes maculas auferendas
 Aqua carnis (antiqui galli)
- 13v., Aqua rubia
 Aqua blodei coloris

Coxe's second item, *Secrets of Hermes*, for which he gives fols. 18v.-52v., 17, and Mrs. Singer (37 v.) fols. 18v.-52v., covers only fols. 18v.-20v., where it breaks off unfinished⁶. Between this point and fol. 52v., several tracts may be distinguished. The first, at fols. 21r.-26r., opens and closes:

Ad liberum cursum planetarum, id est, tabulas astronomie accedere cupientibus. In primis necessarium est investigare quid sit radix planete, quid ecentricus, quid epiciclus, quid aux . . .|. . . diem incipiunt in meridie et cetera.

⁶ See my "Seven Salts of Hermes", and "The Secrets of Hermes", *Isis* 14 (1930), 187-8; 27 (1937), 53-62.

At fol. 24r. it states that the calendar is now 14 days off for the natal day of Jesus Christ and that, if the world lasts for 16,000 years, Christmas will then occur in the summer-time.

There follows, at fols. 26r.-39r., a treatise on the natural causes of things which opens and closes:

Felix qui rerum poterit cognoscere causas⁷. Hinc est quod iste libellus tractat de causis naturalibus rerum . . .|. . . Et sic finitur abbreviatum de impressionibus secundum Aristotelem libro (39r.) *Meteororum*.

It puts the following thirteen questions suggested by the *Meteorologica* of Aristotle:

Et primo queritur que sit causa naturalis tonitrui et chorcuscacionis
Secundo que sit causa naturalis yridis
Tercio que sit causa roris
(26v.), Quarto que sit causa pluvie et grandinis
Quinto que sit causa salcedinis maris
Sexto que sit causa fontium
Septimo que sit causa naturalis fluxus et refluxus maris
Octavo que sit causa quare fontes sunt calidi in yeme et frigidi in estate
Nono que sit causa quare vina raro vel numquam congelescunt
Decimo que sit causa quare terra medium tenet
Undecimo que sit causa terre motus
Duodecimo que sit causa venti et agitationis ventorum
Tertiodecimo an vapor sit materia ventorum et nubium et cetere ut patet in sequentibus.

The answer to the first question is, "extinctio ignis in nube humida"; to the second, "opposicio nubis roride contra solem in quo solis radii imprimuntur"; to the third, "elevacio vaporis frigidi et humidum".

Similar questions as to natural causes in a Corpus Christi College MS. 132, 15th century, fols. 84v.-88r., are sixteen in number and have an introductory paragraph not found in All Souls 81. It opens, "Deus et natura nihil operantur frustra . . .". I give a passage from the third question on dew in All Souls 81, with indication of variants from the Corpus manuscript:

Ut dicit Aristoteles 2^o libro *Meteororum*⁸ quod non fit ros nisi quando ventus australis flat. Nam ventus australis sua humiditate rorem generat et nutrit, quem aquilo (28v.) sua siccitate et intensa frigiditate comprimit et constringit, et ros in summitatibus guttatim se⁹ recolligit et¹⁰ venenum¹¹ venenosis animalibus reprimat. Unde serpentes latitantes

⁷ This quotation from Vergil was a favourite incipit of the time.

⁸ I, 10 of the Greek text.

⁹ Corpus 132, fol. 85r., has *folia* instead of *se*.

¹⁰ Corpus 132 adds *vi*.

¹¹ Corpus 132 adds *in*.

inter herbas¹² parum solent transeuntes ledere, quam diu flores et gramina sunt in rore. Et tantum pro solutione tercię questionis. Dominus Lincolniensis super librum Metheorum inquit . . .¹³.

Our author cites Macrobius, Urso and Algazel as well as Aristotle, but stresses the use of a hollow wax sphere to make sea water sweet and the floating of eggs on salt water as an experiment and a notable experiment of Aristotle:

Quod patet per experimentum quod ponit Aristoteles. Quoniam si homo accipiat sereum (interlinear gloss, instrumentum de cera concavum) novum et clausurit eius orificium cum cera fortiter et eiecerit ipsum in mare per diem et noctem; intrabit in ipsum aqua dulcis. Et ratio est quia cera est corpus porosum, et ideo aqua dulcis subtiliter intrat per poros, et grossicies aque, id est, salsedo intrare non potest. Et illud experimentum ponit Aristotelis in terminis (30v.) 3^o Metheorum in capitulo de ventis¹⁴. Et ibidem ponit quod aqua salsa est gravis, et aqua dulcis est subtilis, ad quod ponit notabile experimentum. Sic inquit. Sal dissolvitur in aqua dulci secundum magnam quantitatem; deinde ponatur in illa ovum, et invenitur ovum natans super aquam propter grossitiem eiusdem aque. Sed in aqua dulci, inquit, submergitur.

The next few leaves are of miscellaneous astronomical and astrological content which may be indicated thus:

39r. Notandum enim est quod luna est propinquior planeta nobis et in tantum est nobis efficacior in effectu secundum tpolomeum (*sic*) in astrologia . . .

39v. De nominibus signorum et de eorum constellationibus tractandum est per ordinem . . .

40v.-45v. On the moon in the signs from Aries to Pisces, opening, Cum luna fuerit in ariete malum est facere opera que vis stabiliri ut matrimonium et societatem et huiusmodi . . .¹⁵

¹² Corpus 132 has *gramina* instead of *herbas*.

¹³ According to S. H. Thomson, *The Writings of Robert Grosseteste*, Cambridge, 1940, pp. 258-9, the *Commentarius in Meteora* is spurious.

¹⁴ In the Greek text at II, 3, on why the sea is salt, before the chapter 4 on winds, at 359a. Nothing is said of experiment there. Webster's English translation, back in 358b, reads, "This I know by experiment". But the corresponding Greek is merely, *πειραμένον λέγωμεν*. In the case of the notable experiment, all that Aristotle says is,

That the thicker consistency is due to an admixture of something is proved by the fact that if you make strong brine by the admixture of salt, eggs, even when they are full, float in it.

Thus experimental method is explicitly stressed by our medieval author, as it was not by Aristotle.

¹⁵ Three verses are added for each sign. Those on Aries run:

Igneus est Aries, sub quo si luna feratur,
Balnea conficias, cruor e brachiis minuatur,
Collo vel capiti nichil a medicis tribuatur.

- 46r. A passage on mobile and fixed signs; then rubric, *Sequitur ordo et numerus sperarum*, expressed in only three verses which end the page.
- 46v. *Nature planetarum sunt hee . . .*
- 47r. Concerning an eclipse and when it is total; a *punctus* is said to be one-twelfth of the diameter; *minutus est 60^a pars eiusdem*.
- 47v. A note as to the moveable feast of St. Matthew. Then
Et sicut naturaliter per constellationes planetarum et siderum multa possunt fieri experimenta et hoc (hec?) veraciter determinata verum etiam ab antiquis philosophis artificialiter comprobata. Quorum primum experimentum est de spolio serpentis. Et sic.

We are herewith introduced to the twelve experiments of John Paulinus¹⁶, here called Iohannes Pauly, at fols. 47v.-50r., opening and closing,

Cum ego Iohannes Pauly percepi in quodam libro egiptiorum qui salus vite appellatur hec 12 experimenta . . . quod sepius probatum est. Et sic explicant 12 experimenta naturalia de spolio serpentis quibus potest quis uti sine peccato quia naturalia sunt.

Then follow other tricks of natural magic (fols. 50r.-52v.):

Sequuntur et alie cautele que possint fieri secundum cursum nature sine periculo et sic. Ut omnes candelae accense in domo ab uno illuminantur, si simul sint extincte . . .

This is done by a connecting thread which has been dipped in live sulphur and Greek pitch (*colophonia*). Others are

Ut stramina sint sicut serpentes

Ut habeas aquam fluentem in domo

Ut dentes cadant sine dolore (use of goat's dung and mulberry)

Ut possis portare ignem ardentem in manu tua

Ut cuniculi leviter capiantur

Experimentum mirabile et forte aliquibus incredibile, tamen naturale est

Si equus tuus fuerit fessus in itinere (an incantation is to be whispered in his ear thrice)

Ad faciendum carnes coctas apparere crudas.

The marvellous but natural experiment at fol. 52r.-v. was:

Vade ad nidum yrundinis in tempore generationis eius, et specialiter quando habet pullos, inter horam primam et horam nonam per tres dies continuos et penetra cum stilo oculos pullorum. Et die vero iii ad talem horam pulli videbunt; tunc invenies in medio eorum tres lapides, scilicet, rubeum, album et viridem. Si habeas rubeum, non eris vulneratus. Si viridem in ore tuo habeas et osculatus fueris aliquam mulierem, amabit te. Si vero album habeas, ab omnibus pericula liberaberis et valet maxime pro muliere pregnante.

¹⁶ See *A History of Magic and Experimental Science*, II, 794-6.

The tricks are then continued on fol. 17, which explains Coxe's reference to it:

Ut candela ardeat in aqua
Pone vervenam in quatuor partibus horree tue et mures non corrodent
grana tua.

But on fol. 17v., after treating of marvellous herbs and birds, the text breaks off unfinished.

The passage ending, "Explicit ycocedron philosophie", which Mrs. Singer's catalogue quotes as if on fol. 52v., is actually on 18r., and is the close of the 19th chapter of Walter of Odington's *Icocedron*¹⁷.

After a blank leaf (fol. 53r.-v.), comes a recipe in English by John Halle on 54r., opening, "Take a quantite of alem brimestone salmoniaca salpeter and comen salt . . ." and another, "For to staunche blode", opening, "Take ye blode of hym yat bledyth . . .". On 54v. are two paragraphs in Latin, which open, "Si vis facere hominem dormire . . ." and, "Quare omnes homines non sunt eiusdem qualitatis et quantitatis . . .".

We now come at last to the third item in Coxe's catalogue which is

fol. 55. Sexta particula Arnaldi de Villa-Nova in qua capitula tredecim,
opening, Postquam dictum est supra in pleno introductorio . . .

In none of the works of Arnald of Villanova, in the *editio princeps* of 1504, is there any treatise with such a *particula* and chapter, but there may have been a different division of his works in manuscript copies of them. The titulus in the manuscript itself is more informing:

Incipit feliciter sexta particula introductorii Arnaldi de Villanova continens xiii capitula. Unde xii eorum pocius astronomie quam phisice senceantur. Quorum primum capitulum est de certis experimentis.

Of these the first fifteen deal with medicinal simples, chiefly herbs: Aloe, Anacardi, Coloquintida, Coconidii fructus, Castorei, Catapucia, Scamonie, Ellebori, Blacterii, Euforbii, Esuli, Ebuli, Ferruginis, Fumi terre, Mirabolanorum. Then

- 60c. 16m experimentum est de duritie splenis
- 61r. 17m experimentum est de feto mortuo
- 18m experimentum est ad extrahendum secundinam
- 19m experimentum est contra scabiem
- 61v. 20 de cancro oris
- 21 whether vulneratus will die
- 22 contra puncturam (62r.) nervi

¹⁷ As stated in *A History of Magic and Experimental Science*, III, 129, note 47.

- 62r. 23 contra contusiones
 24 ad faciendum claretum
 62v. 25 de inflacione
 63r. 26 de igne perpetuo.

After this long first experimental chapter, the other twelve, from 63v. to 73v., are concerned with *sigilla* or seals of the signs of the zodiac, a subject on which a text is contained in the 1504 edition of the works of Arnald of Villanova.

The fourth entry in the catalogue is for a chapter on the seven planets at fol. 74r., which opens,

Gloriosus deus in omnibus rebus creandis ordinavit in septem speris
 celi 7 planetas . . .

and tells of their astrological influences. It ends at fol. 77v., "Explicit capitulum de 7 planetis", while the next item noted in the catalogue does not occur until fol. 98, the reason being that fols. 78-97 are not found in the manuscript.

What Coxe represented as a single item at fol. 98, consisting of

Versus viginti duo (actually there are 23) alchemici auctore Conrado de
 Hildensee nonnullis subijunctis praescriptis eiusdem nature

was split into two texts by Mrs. Singer's Catalogue (IIII, xc, and 801 ii) thus:

fols. 98v.-99v., Colours and charms etc.
 fols. 98-100, Expliciunt versus M. Conradi de Hildensee.

So far as he went, Coxe's pagination is the more correct, since the verses of Conrad both begin and close on fol. 98r.:

Cogitur exire spiritus de corpore Iovis . . ./. . . Expliciunt versus
 M. Conradi de Hilsenser (as I read it).

A recipe of herbs etc. occupies the last six lines of the page. One may further distinguish at

fol. 98v., Ad faciendum finissimum azurium. Recipe flores gaudii(?)
 et pone in pelvi cum lixivio communi . . .

and at

fol. 99v., Pro spasmo. Fiat carmen vel breve de quo fit mencio isto
 modo . . . (Use is made of signs of the cross and names of angels.)

Passing over John of Rupescissa on the fifth essence¹⁸ at fols. 100r.-132v.,

¹⁸ See Singer, 292, xxv (I, 273); *A History of Magic and Experimental Science*, III, 358-63, 726, 730-2.

and Alexus Affrike on seven herbs¹⁹, at fol. 133v., we come to the eighth item on the judgments of Alkandrinus, at fols. 145v.-163v. Coxe's extension of this text to fol. 188 has previously been corrected by me²⁰. It is followed by a work of astrological medicine at fols. 163v.-183v., which opens, "Istis iudiciis trans-actis restat videre . . ."²¹. I may add here some further description of the contents of fols. 183v.-188r.:

- 183v. Sequitur ulterius de signis. Luna in ariete sanguinem de brachiis minuere bonum est et balneis uti. Capiti vero nullum medicamentum adhibeas . . .
- 187r. . . . Modo de societate adquirenda . . .
- 187v. De incarceratione. Si quis incarceratus fuerit luna existente in ariete statim exibat . . .
- 188r. Et nota quod omnia supradicta infallibiliter sunt vera secundum naturas signorum et planetarum, sed quomodo deus vult castigare mundum inferiorem, de hoc non iudicamus.
Expliciunt iudicia signorum et planetarum per manus D.R. 1474 cuius anime propicietur deus. Amen.

Coxe noted a fragment at fol. 188v., "de horis signorum et planetarum", opening, "Et nota quod Saturnus Martem metuit . . .". This is in the same hand of D.R. and seems to break off at 189v. Fol. 190 is missing, and two leaves have been cut out. The remainder of the manuscript is in different and later hands. It deals with dream books, physiognomy, chiromancy and heraldry, and is more adequately catalogued by Coxe (items 10 to 17) and noted by me elsewhere, except that the incipit of the very first item at fol. 191r.-v. has not been noted. It is entitled, "Nota hic domos septem planetarum", and opens and closes: "Intelligendum est quod sol habet unam domum . . ./ . . . florebit sine dubio et cetera"²².

¹⁹ Singer, III, 772-3; *History of Magic*, II, 233, note 2.

²⁰ *Ibid.*, I, 715, note 3.

²¹ Noted in *A Catalogue of Incipits*, col. 374.

²² Two love charms follow: *Ut mulier sequatur te*, and *Aliud ad habendum amorem*; then fol. 192r.-v. is blank.

THE REDEMPTION THEME AND HELLENISTIC ALCHEMY

BY H. J. SHEPPARD

IN a recent paper¹ the writer sought to show that much of the abstruse symbolism of late alchemical texts stemmed from the fusion of nascent Hellenistic alchemy with gnosticism. Apart from the comment that later gnostics evidently regarded alchemy as "part of a Divine plan", no remarks were made on the nature of the esoteric art which arose out of the fusion. That consideration of this should now be attempted seems desirable, if only as a rational counter to the extraordinary claims of 19th century occultists, or as a factual basis for the more scholarly speculations of contemporary interpreters such as Evola, Canseliet, d'Ygé and others².

The influence of oriental ideas upon Greek religious thought and philosophy had become very marked by the dawn of the Christian era. One outcome of this was the conviction frequently expressed by writers of the period that there existed "an ancient doctrine of nature among both Greeks and barbarians, a philosophy of nature (*physikos logos*) concealed in myths, largely hidden in enigmas and allegories (*hypnoia*). Its interpretation is provided by the things done symbolically in religious rites"³. To interpret this philosophy, to rescue it from its obscurity, was the task of the philosopher and theologian; this could be accomplished by allegorical exegesis. Traditional works of all kinds were interpreted in such a fashion—often with interpolations—that they harmonized with the doctrines of the interpreters. As Halliday remarked⁴, such a procedure could not but result in a totally unscientific attitude of mind, preferring as it did to reject the obvious meaning in favour of a far-fetched esoteric explanation.

The current of Stoic ideas common to both alchemy and gnosticism has already been discussed, but these alone could hardly have been sufficient reason for the gnostic adoption of alchemy; the latter must have appeared to offer enlightenment upon the doctrine which lay at the heart of gnosticism—the path to *soteria*, or redemption⁵.

¹ H. J. Sheppard, "Gnosticism and Alchemy", *AMBIX*, VI, No. 2 (1958), pp. 86 ff.

² E.g. J. Evola, *La Tradizione ermetica*, Bari, 1948; E. Canseliet, *Deux Logis Alchimiques*, Paris, 1945; C. d'Ygé, *Nouvelle Assemblée des Philosophes Chimiques*, Paris, 1954.

³ R. M. Grant, *The Letter and the Spirit*, London, 1957, p. 23. This excellent little work deals with the allegorical interpretation of early literature, ranging from the poetic inspiration of Homer up to the Patristic writings of the 3rd century A.D.

⁴ W. R. Halliday, *The Pagan Background of Early Christianity*, Liverpool and London, 1925, p. 183.

⁵ S. Angus, *The Religious Quests of the Graeco-Roman World*, London, 1929, Chap. XX, *passim*.

In contrast to earlier Greek religion wherein the fate of the individual was linked to that of his fellow worshippers of the gods of the city-state, salvation was now a personal affair. The decay of the city-state by the time of the Roman conquest saw the decline of the old gods; there arose instead an individual appeal for *soteria*, for a gospel which would ensure relief from the cloying sense of finitude and the bodily tomb of the soul. The theme was certainly not a new one; it originated with the Orphics, from whom it was adopted by Pythagoreans, and later came to the forefront in Stoicism, gnosticism and in all the popular mystery-religions which lasted up to the end of the 4th century A.D.⁶

Throughout the Hellenistic period religion, philosophy and scientific thought had become increasingly inseparable. In the field of cosmic speculation, in the manifold phases of thought—cosmogonies, theogonies, astralism, pantheism, etc.—we can discern the continuous unfolding of a unitary conception of the cosmos. In the *Timaeus*⁷ Plato had already decreed that the controlling influence over all parts of the universe was Mind, for which Aristotle substituted Reason⁸. By a blending of Platonism and oriental mysticism the Stoic Poseidonios propounded a cosmos permeated by Soul, a cosmos which, like man, was the image of God⁹. In the words of a later Stoic, "there is both one cosmos of all things, and one God through all, and one Substance, and one Law and one common Reason of intelligent beings, and one Truth"¹⁰. God and nature were identified.

The gnostic, utilizing current philosophy, was convinced of this rigorous parallelism between the universe and human kind; he was convinced that man could discover the intimate secret of the unity of the world by involving himself in the processes which lay behind the unfolding scenes of the world drama. Beneath the sensible world in perpetual transformation the mystic beheld the kingdom of Spirit. The whole of the corruptible was for him a simple image of the incorruptible¹¹.

The first task was to find a connexion between two problems: that of the creation of the world—terrestrial matter, evil in origin—and the question of salvation. How was it to be accomplished? The key lay in the fact that man, as part of matter, had within him a fragment of the Logos, or divine Spirit. He must throw off his corporeality and the Logos would lead him back

⁶ *Ibid.*, *The Mystery Religions and Christianity*, London, 1925, Chap. II.

⁷ *Ibid.*, pp. 69–70.

⁸ *Ibid.*

⁹ *Ibid.*

¹⁰ Marcus Aurelius, *Meditations*, VII, 9.

¹¹ H. Leisegang, *La Gnose*, Paris, 1951, pp. 33–4.

to God; he would be raised from the corporeal to the psychic and thence to the spiritual state. For this the neophyte underwent a profusion of ceremonies and initiations: one degree led to another, initiation followed preparation, as in the mystery-religions, until the spiritual redemption was completed. Keeping in mind, then, the general acceptance of the unitary conception of matter, it is not difficult to see how early alchemical texts could have been interpreted allegorically as symbolic of the redemption process. The ill-arranged fragments which form the *Physika kai Mystika* attributed to the Pseudo-Demokritos¹², though concerned chiefly with technical processes, offer several themes which lend that work the necessary air of mysticism for gnostic and Hermetic usage.

In the *Physika* we learn from the narrator how he visited Egypt to perfect his studies on the nature of matter¹³. Upon his arrival in that country he was fortunate enough to find as teacher the Persian magus Ostanès, sent there, it was said, by the kings of Persia to instruct the priests of the temples of the Pharaohs. Unfortunately, before Ostanès could complete his mission, he died somewhat mysteriously of poisoning, leaving Ps-Demokritos at the stage when he was conversant only with the different properties of the many forms of nature. Before transmutations could be effected it was vital to know the secret of combining the different natures—that is, the laws of sympathy and antipathy which were operative; accordingly, Ps-Demokritos evoked from Hades the ghost of his late master and entreated him to reveal the desired knowledge. But faithful to magian tradition, which precluded the transmission of such wisdom to any but the son of its possessor, Ostanès declared that the presence of his guardian demon prevented him from talking; he would reveal only that the books of his art were to be found in the temple.

After a fruitless search, the distraught Ps-Demokritos set himself the task of preparing the necessary starting materials, a task which he completed successfully and celebrated at a feast held in the temple. During the celebrations a pillar of the temple suddenly split wide open to reveal an apparently empty interior. To the surprise of the gathered company the son of Ostanès, after groping within the column, withdrew the books deposited by his father; inscribed therein was the information desired for the completion of transmutation, summed up in the formula: "The nature, in such a case, is charmed by the nature: in such a case, triumphs over it; in such a case, dominates it"¹⁴.

¹² M. Berthelot, *Collection des anciens alchimistes grecs*, Paris, 1888, II, pp. 41 ff.

¹³ J. Bidez, F. Cumont, *Les Mages Hellénisés*, Paris, 1938, I, pp. 198–207; II, pp. 317–20.

¹⁴ I have preferred, with A. J. Festugière, the rendering of J. Bayet (*Rev. Ét. L.*, 1946, pp. 370 ff.) in contrast to that of H. Diels (*Antike Technik*, Leipzig and Berlin, 1924, p. 131): "A nature is charmed by another nature, a nature triumphs over another nature, a nature dominates another nature". For a discussion of the meaning of this, *vide* Festugière, *La Révélation d'Hermès Trismégiste*, Paris, 1950, I, pp. 433–4.

As Festugière has pointed out¹⁵, such a story contains five themes commonly met with in Hellenistic literature:

- (a) A painstaking search after truth—in this case for the occult sympathies between substances. For gnostics and Hermetics this would represent the revealing of the way to salvation.
- (b) The realization that this truth could not be attained by one's own efforts but only by revelation from a divine master.
- (c) The evocation of the spirit, or ghost, of this master.
- (d) A ban upon the divulging of the revealed knowledge to any but the son of the master.
- (e) The discovery in the temple of a stele upon which was inscribed the secret information.

An equally direct suggestion of the redemption motif is to be found in a later passage of the *Physika*: "Those people who, on a rash and thoughtless impulse, seek to prepare the remedy which would heal the soul and rid it of all affliction, do not understand that they will go to their doom"¹⁶.

From the general tenor of the *Physika kai Mystika* there is nothing to suggest that the author was influenced by gnosticism; if esoteric knowledge is implied—as seems evident—it is asserted by a practising alchemist for whom the relation between matter and spirit (the corporeal and the incorporeal) is implicit in the unitary conception of matter.

On the practical side we have the ritual of changes undergone by the base materials during the transmutation process. The proximate materials when heated became blackened (*melanosis*) to form the *prima materia*—a liquid state. By further treatment which utilized the laws of sympathy and antipathy in uniting with the *prima materia* substances having the requisite affinities, further colour changes were observed: whitening (*leukosis*), yellowing (*xanthosis*) and in certain cases a reddening (*iosis*)¹⁷. Little imagination would have been required to liken this symbolically to the ritual observed by a participant in one of the mystery-religions prevalent at the time—an interpretation which we described earlier as "provided by the things done symbolically in religious rites"—as a glance at the following table of correspondences will show¹⁸.

¹⁵ *Révélation*, pp. 229–30.

¹⁶ Berthelot, *Collection*, II, p. 47.

¹⁷ Festugière, *op. cit.*, p. 234.

¹⁸ This table is adapted in part from that of the astrologer Antiochos of Athens (2nd century A.D.), reproduced by J. Seznec, *The Survival of the Pagan Gods*, New York, 1953, p. 47.

COLOUR	ELEMENT	METAL	MACROCOSM	MICROCOSM
Black	Earth	Lead	Saturn	Body
White	Water	Silver	Moon	Spirit
Yellow	Fire	Gold	Sun	Soul

The transition from body to soul represented the redemption process; on the alchemical plane the transmutation from lead to silver to gold which followed the colour sequence black-white-yellow must therefore have symbolized redemption in the metallic kingdom.

To follow the development further is unnecessary; the works of the Hermetic philosopher and alchemist Zosimos of Panopolis¹⁹ (ca. A.D. 300) show clearly that the esoteric side of his works is concerned with a gnostic way of redemption. A full analysis of the appropriate parts of these texts has been given elsewhere by C. G. Jung²⁰.

In attempting to establish the earliest link between alchemical texts and those that are truly gnostic or Hermetic in character the writer has relied heavily upon several previous writers, notably the late Franz Cumont, Joseph Bidez and Hans Leisegang; and in addition A. J. Festugière and R. M. Grant, for which he would gratefully tender his acknowledgements.

¹⁹ Berthelot, *Collection*, II, pp. 107 ff.

²⁰ C. G. Jung, *Psychology and Alchemy*, London, 1953, pp. 346 ff.

F.-J. BONJOUR AND HIS TRANSLATION OF BERGMAN'S
"DISQUISITIO DE ATTRACTIONIBUS ELECTIVIS"

BY W. A. SMEATON*

BERGMAN'S important dissertation on chemical affinities, "Disquisitio de attractionibus electivis", was first published in Latin in 1775¹, and a French extract, by an anonymous translator and without notes, appeared in 1778². A revised and enlarged version, again in Latin, was published by Bergman in 1783, in vol. III of his *Opuscula physica et chemica*. The first two volumes of the *Opuscula* were translated into French by Guyton de Morveau³, but he did not translate the later volumes, and most of their contents therefore remained unknown to French readers.

A French translation of the final version of the dissertation on affinities, as it appeared in vol. III of the *Opuscula*, was, however, published in Paris in 1788 as an octavo volume of more than four hundred pages, containing a supplement and copious notes added by the translator, who was anonymous⁴. It has not been noted by subsequent bibliographers that, in his list of important chemical books, Fourcroy named Bonjour as the translator and author of the notes⁵.

François-Joseph Bonjour, the son of a farmer, was born at Onglières, in the French Jura, on 12 December, 1754, and died at Dieuze, in Lorraine, on 24 February, 1811. From a short biography written by his nephew⁶, we learn that Bonjour was sent by his two uncles, who were churchmen, to a seminary at Besançon but that he soon gave up theology and went to study medicine in Paris. Here his interests again changed, and he joined the small fraternity of professional scientific workers. In 1783 he was a demonstrator in the Queen's botanical garden, and soon afterwards he was employed by Berthollet as an

* This paper was written during the author's tenure of a research fellowship, awarded by the Centre National de la Recherche Scientifique, in the Institut d'Histoire des Sciences et des Techniques, Université de Paris.

¹ *Nova Acta Reg. Soc. Sci. Upsal.*, 1775, **2**, 108-60.

² *Obs. sur la Phys.*, 1778, **13** sup., 298-333.

³ *Opusculs chymiques et physiques*, 2 vols., Dijon, 1780 and 1785. For information about other translations of Bergman's works, see Birgitta Moström, *Torbern Bergman. A bibliography of his works*, Stockholm, 1957.

⁴ *Traité des Affinités Chymiques, ou Attractions Electives; traduit du Latin, sur la dernière édition de Bergman. Augmenté d'un supplément & des notes.* 8vo, pp. (8) + 444 + (2) + 4 plates + 3 tables. Paris, Buisson, 1788.

⁵ A. F. Fourcroy, *Encyclopédie Méthodique, Chimie*, Vol. III, Paris, an 4 (1795-6), p. 758.

⁶ Jacques Bonjour, *Notice biographique sur Bonjour, J. F., chimiste . . .*, 8vo., 8 pp., Lons-le-Saunier, 1853.

assistant in his laboratory, where he took part in many of Berthollet's experiments, particularly those on the use of chlorine as a bleaching agent.

Berthollet sent his assistant to Valenciennes to apply the new bleaching process on a large scale, and when the town was besieged by the Austrians in 1793, Bonjour took part in the defence, first as a gunner and later, after being wounded in the arm, as a pharmacist. He remained at Valenciennes until the end of 1794 as the local commissioner for saltpetre production, and on his return to Paris he became an instructor in chemistry at the Ecole Polytechnique, where Berthollet was one of the professors⁷. The Ecole Polytechnique was a very active centre of research, and while he was there Bonjour attempted, with Hassenfratz and others, to measure the latent heat of fusion of mercury⁸, and he carried out some experiments with prussic acid, prepared by the action of ammonia on heated charcoal⁹. However, Bonjour was suited for an administrative rather than an academic career, and in 1797 he was sent by the government as a commissioner for the production of salt and chemicals in the east of France, where he remained until his death. In his later years Bonjour took an interest in agriculture, and it had been his intention to retire to his native Jura and carry out agricultural improvements.

Bonjour translated Bergman's essay on affinities while he was working with Berthollet, and his manuscript was completed by 8 October, 1787, when the approbation, printed at the end of the volume, was signed by Fourcroy, one of the Royal Censors responsible for scientific books. On the title-page the translation was stated to be from the Latin edition, but the *privilège du Roi*, printed after the approbation, described the work as being translated from English. Bonjour certainly consulted the English translation¹⁰, for in his own notes he referred to some of those of the English translator.

The translation of Bergman's text occupied pp. 1-259, and to this Bonjour added a supplement (pp. 260-89) in which he gave a brief account of the affinities of some acids discovered since Bergman had written. This supplement was based on Guyton de Morveau's account of these acids, published in 1786 in the first chemical volume of the *Encyclopédie Méthodique*. Some of this new information was also given by Bonjour in three additional tables of affinities, in which he used the names of substances instead of Bergman's inconvenient symbols, which were, however, retained by Bonjour in the original tables. Throughout his translation Bonjour made no attempt to adopt a consistent nomenclature, but used the systems of Bergman and de Morveau,

⁷ A list of the staff appeared in *J. Ecole Poly.*, 1796, 1 (cahier 3), xviii.

⁸ *Ibid.*, 1795, 1 (cahier 1), 123-8.

⁹ *Ibid.*, 1796, 1 (cahier 3), 436-9.

¹⁰ *A Dissertation on Elective Attractions*, London, 1785. (Translated by Thomas Beddoes.)

together with some of the traditional names¹¹. He explained in his preface that his work was nearly completed at the time of publication in 1787 of the *Méthode de nomenclature chimique* by de Morveau, Lavoisier, Berthollet and Fourcroy: if this had appeared earlier he would have adopted the new nomenclature.

Bergman was a phlogistonist, and, where necessary, interpreted his observations in terms of Scheele's modification of the phlogiston theory. Bonjour did not interfere with Bergman's text, but at the end of the volume (pp. 290-434) he added long notes, in which he gave the anti-phlogistic explanations of the phenomena described by Bergman, so that readers could decide for themselves in favour of one theory or the other. These notes consisted largely of extracts from the writings of the anti-phlogistic chemists, particularly Lavoisier and Berthollet, and few readers can have failed to be convinced by them. The same method of attack was employed in 1788 by Lavoisier and his colleagues when they added notes at the end of Madame Lavoisier's French translation of Kirwan's *Essay on Phlogiston*, replying to Kirwan's phlogistic arguments, chapter by chapter.

Bonjour benefited from his contact with Berthollet while he was preparing his notes, for, in his criticism of Bergman's theories of the nature of dephlogisticated marine acid (chlorine) and *aqua regia* (pp. 335-53), he included extracts from two of Berthollet's papers which were published in 1788, after Bonjour's manuscript was completed¹²; and in his discussion of sulphurous acid (pp. 312-3) he referred to the work of Berthollet which was not published until 1789¹³, stating that Berthollet "has willingly informed me of his results".

One final point may be noted. In his preface Bonjour stated that in preparing the translation of Bergman's essay he had taken the opportunity to give an idea of "the theory which the French Chemists have substituted for that of this illustrious professor", and, in discussing the composition of nitric acid (p. 324), he contrasted Cavendish's explanation with that given by "M. Lavoisier and the other French chemists". In his *Mémoires de Chimie*, printed before his death and published posthumously by his widow, Lavoisier showed how Fourcroy, de Morveau and Berthollet did not adopt the anti-phlogistic theory until several years after he himself had almost perfected it, and he wrote, "This theory is therefore not, as I have heard it said, the theory of the French

¹¹ The author has discussed the systems of Bergman and de Morveau in *Annals of Science*, 1954, **10**, 87-106.

¹² C. L. Berthollet, "Mémoire sur l'acide marin déphlogistiqué", *Mém. Acad. R. Sci.*, 1785 (pub. 1788), 276-95; and "Observations sur l'eau régale . . .", *ibid.*, 296-307. A short account of the first of these had appeared in *Obs. sur la Phys.*, 1785, **26**, 321-5, but Bonjour's extracts are from the full version.

¹³ *Ann. de chim.*, 1789, **2**, 544 ff.

Chemists: it is *mine* ('elle est *la mienne*'), and it is a property to which I lay claim before my contemporaries and before posterity"¹⁴. Lavoisier did not say where he had heard or read the offending expression, but Bonjour seems to have been the first to use it in print.

¹⁴ A. L. Lavoisier, *Mémoires de chimie*, n.p., n.d., vol. II, p. 87. Most bibliographers state that Madame Lavoisier published the *Mémoires de chimie* in 1805, but it has been shown by J. R. Partington (*Chem. and Ind.*, 1955, 1475) that Berthollet quoted from the work in 1803. The evidence has been discussed by the present author in *The Library*, 1956, 132-3.

REVIEWS

A History of Magic and Experimental Science. By LYNN THORNDIKE. Volumes VII (pp. x + 695) and VIII (pp. viii + 808). The 17th Century. New York, Columbia University Press; London, Oxford University Press, 1958. Price 80s. each volume.

PROFESSOR THORNDIKE's introductory remarks recall that the viewpoint and plan in his previous volumes has been not unlike that of Gilbert Charles le Gendre who, in 1733, published his *Traité de l'Opinion ou Mémoires pour servir à l'Histoire de l'Esprit Humain*. We are reminded that Le Gendre wrote in order to demonstrate what excesses the human mind was capable of, and to make it impossible that they should ever delude mankind again.

In this present work on the 17th century, Professor Thorndike carries his survey "up to the very brink of that period when Le Gendre felt that errors had been abandoned." This conspectus should be kept in mind: for while many of the citations of texts contain material which may seem at first to be *sui generis* somewhat repetitious, they are illustrative of the numerous outworn beliefs and ideas that still lingered on tenaciously in the 17th century. Moreover, many books which claimed to present new ideas, or experiments, were, in fact, made up largely of quotations from previous writers. Thus, for example, in the chapter on "Kepler and Galileo", Professor Thorndike points out that Kepler's *Mysterium cosmographicum*, of 1596, was possibly suggested by Campanus of Novara's 13th-century commentary on Euclid's *Elements*; and that although Galileo's *Dialogues Concerning Two New Sciences* are full of passages laying claim to extreme novelty, he mentions some experiments which go back at least to Henry of Hesse in the 14th century, and to Adelard of Bath in the twelfth century. The views and achievements of some of Kepler's and Galileo's contemporaries are next discussed: this is succeeded by an exposé of Francis Bacon "who was", says Professor Thorndike, "a crooked chancellor in a moral sense, and a crooked naturalist in an intellectual sense; though his tendency to explain natural phenomena by the action of corporeal spirits became widespread and general".

Following after an important account of "Astrology to 1650" we come to the chapter on "Alchemy and Iatro-Chemistry to 1650", which begins by recounting the opinion of an early 17th-century writer who considered that the alchemists of his day spent more time in scribbling than they did in experimenting. This tendency is exemplified in the case of Agnolo della Casa of Florence who, between 1592 and 1618 filled some eighteen volumes of from 100 to 900 leaves each, with matter that was mainly alchemical. And much of this scribbling consisted of quotations *ad nauseam* from earlier writers. Later in this section, it is stated that both Michael Maier and Robert Fludd were Rosicrucians. This designation, it might be added, is open to question; and it has been pointed out (*cf. Ambix*, 1949, 3, p. 100) that neither Maier nor Fludd ever professed themselves in their works to be members of the Rosicrucian Fraternity, although it was defended by them on the assumption that the order had a tangible and corporate existence. Among the very many alchemical books described in this chapter, is Jean Saignier's *Magni lapidis naturalis philosophia et vera ars in opus deducta et filio suo Carolo relicta, et in agone mortis propria manu subsignata, Parisiis, Die 7 Maij; Bremae, 1644*.

It contains the following closing words: "By my hope of heaven I have declared to you what my eyes have seen, my hands have operated, my fingers have extracted. And I have written this booklet with my own hand, and signed it with my name, when I was in the last agony the year 1632, May 7." This date, Professor Thorndike tells us, should be May 7, 1432, as manuscripts of the work show. It is tempting to regard this curious declaration as reminiscent of "the true Matter of the Philosophers' Stone" which, according to Elias Ashmole, was bequeathed to him "in Silables" by William Backhouse on 13 May, 1653.

After interesting and critical accounts of Daniel Sennert, and Van Helmont—the latter would not admit that calcined tin weighed more than crude tin, despite Jean Rey's published experiments—there is a noteworthy discourse on "Natural Magic"; and here this term is defined as the working of marvellous effects which may seem preternatural, by a knowledge of occult forces in nature without resort to supernatural assistance.

Next, there are chapters on "Magic in Portugal and Spain"; on "Interest in the Occult at German Universities"; on the "Cursus Philosophicus" before Descartes"; and on "Mersenne and Gassendi", with a section on Robert Fludd; and Gassendi's summarization of Fludd's philosophy is cited.

The remaining chapters in this volume are on "The Scotist Revival"; "Morin's *Astrologia Gallica*"—which was an attempt to defend, rehabilitate and reconstruct judicial and genethliacal astrology; on "Drebbel and Digby"; "Harvey and Patin"; "Descartes"; "Kircher and Becher"; "Artificial Magic and Technology"; "Huygens"; and finally, on "Physics and Astronomy after Descartes".

Volume VIII begins with a dissertation on "Natural History, especially of Animals"; and as might be anticipated, Robert Lovell's *Panzoologicomineralogia*, 1661, is not omitted from the literature surveyed. In his book, Lovell divides both animals and insects among the seven planets.

The next chapter, "Botany", closes with a citation of Thomas Baker's admission, in his *Reflections upon Learning*, 1699, that progress had been made in classifying plants and describing them by their marks and signatures; but he complained that their virtues were yet unknown. Pierre Pomet's *Histoire général des drogues* is mentioned in the discussion on "Pharmacy". The first English translation of this book appeared in 1712. Professor Thorndike does not cite the translator's name, but according to the B.M. Catalogue, he was Joseph Browne, M.D.

Under the heading "Chemical Courses and Manuals", we are given an interesting and critical account of important printed texts as, for example, the *Tyrocinium chymicum*, 1610, of Jean Beguin. It is mentioned that this was the earliest textbook to obtain much currency; and it defined alchemy as an art which teaches to separate the pure from the impure—a definition which was absent or altered in later editions. A useful reference to T. S. Patterson's paper on Beguin (*Annals of Science*, 1937, 2, 243) has been omitted.

In the succeeding chapter on "Robert Boyle", L. T. More's biography is criticized. More appears to regard Boyle as a chemist, rather than a physicist; and yet this impression is not consistently presented, remarks Professor Thorndike; and as he rightly adds: "In Boyle we have an example *par excellence* of one beginning to shuffle off the mystic robes of the magician and putting on

some of the habiliments of modern science." While there is much to be said in agreement with the opinions expressed in this chapter, Boyle's services to experimental chemistry have not been, until recently, fully assessed. And one ventures to disagree with the further suggestion that few will buy Boyle's writings and "hence they are perpetually offered for sale, or that those who do buy them, and then try to read them, soon return them at a low price to the market". This has certainly not been the experience of book buyers in Great Britain during recent years.

Following after sections headed "Other Exponents of Experimentation"; "Academies and Scientific Societies"; and "Miscellaneous and Popular Science", the subject of "Astrology After 1650" is discussed; and we then come to another important chapter on "Alchemy and Chemistry After 1650." In the late 17th century there was perhaps more interest in a universal medicine than in the transmutation of metals. Johan Ludwig Frundek's *Tractatus de elixire arboris vitæ, id est, medicina mea universali*, 1660, is one of the rare books noted in this connexion. Another such text is that of Montesnyder ["Mondschneider" according to Schmieder], though his book *De medicina universali*, 1678, is more alchemical than medical—and incidentally, it was much esteemed by Newton. It is interesting to note in this epitome that an anonymous writer, Panteleon, (the pseudonym of Franz Gassmann), published in 1676, at Nürnberg, two works which revived the "mercury-alone" doctrine that was described by Professor Thorndike in a previous volume (Vol. III), as a favourite and prevailing theory of transmutation in the 14th and 15th centuries. At the close of this chapter, mention is made of Johann Ludwig Hannemann's writings (of 1694 and 1696) concerning natural and artificial gold, and the analogy of theological mysteries in connexion with the Philosophers' Stone. It is appositely remarked that even after more than thirty years had elapsed since the appearance of Robert Boyle's *The Sceptical Chymist*, chemistry could still indulge in religious rhapsodies and magic dreams. In the section "Medicine and Physiology", John Mayow's position in the history of science receives much attention. The generally accepted opinions of T. S. Patterson *et al.*, are criticized, and it is opined that Mayow did suggest the existence of oxygen. It is postulated that whether Mayow did, or did not, originate "as much as used to be held, . . . the fact remains that he erected a sign-board or sign-post which was more likely to strike the eye of future historians than scattered passages in the writings of Lower, Hooke, and Boyle—and that sign-post pointed in the direction of the discovery of oxygen".

The next subject-heading is "Physiognomy"; and here the *Chirologia* of J. Bulwer is mentioned, but not his *Anthropometamorphosis*, 1653, with its many illustrative woodcuts. Lastly, after succeeding chapters on "Divination", "Mental Disease and Magic", "Illicit Magic", and on "Sir Isaac Newton", Professor Thorndike concludes this volume with an account of a number of books printed or written between 1687 and 1700, and other works of a retrospective and critical outlook, which afford us "a final glimpse of the state of thought with regard to magic and experimental science at the close of the 17th century".

These two volumes of Professor Thorndike's masterly-written treatise are an impressive finale to a work that is indispensable to the historian of science.

D. G.

Libellus de Alchimia (ascribed to Albertus Magnus). Translated from the Borgnet Latin edition: Introduction and Notes. By SISTER VIRGINIA HEINES, S.C.N. With a Foreword by Pearl Kibre. Pp. xxii + 79. 8 Plates. University of California Press, 1958. (Obtainable from Cambridge University Press.) Price 26s.

THIS little treatise, ascribed to Albertus, is divided into fifty-seven brief chapters; most of the chapters have one or more paragraphs of additional discussion, and these paragraphs have been added to the original text at a date much later than the first recension of the text. In these "additions", titles of books written after the time of Albertus are cited, and reference is made to persons who lived long after the date of his death.

Albertus begins his treatise by saying that he will write of nothing but what he has seen with his own eyes: "*nihil aliud scribam nisi quod oculis meis vidi*". He offers a derivation for the word "alchemy", a theory of the origins of metals; this is followed by eight precepts for the practitioner of the art to observe. He then discusses the location of the laboratory, remarks on the best time of the year to engage in certain experiments, discusses the mental attributes that are essential for the worker to possess, and describes the processes of calcination, distillation, precipitation, sublimation, fixation, and the like. After that, in several chapters, he describes the equipment in the laboratory: tools, vessels, utensils, furnaces. This discussion is followed by an account of the "spirits" of metals, the elixir or philosophers' stone, descriptions of various minerals, chemicals and dyes. Succeeding chapters give instructions for the making of powders, solutions, and other processes necessary to the art. The concluding chapters give short recipes for the making of precious metals.

Sister Heines deserves great praise for having made this text accessible to students of alchemy. She has written a scholarly introduction, which includes an enumeration of the manuscript sources. She has annotated the text throughout with very helpful notes, and being a trained chemist these notes are especially valuable. On p. 27, in her note on Djabir, the great work by Kraus might have been mentioned; and in her note, p. 73, on the "philosophers' stone" it may be doubted whether this term was first used in the 7th century.

This treatise is based theoretically upon Aristotle's doctrine that all matter is composed of four basic substances and it is reminiscent of similar treatises by Arabian authors. The "philosophers' stone" is only and vaguely mentioned once, and there is no attempt to explain how to transmute baser metals into gold, though several techniques for gilding these metals are described. In many ways this treatise corresponds to the plan of a textbook of modern general chemistry, and it is fitting that Sister Heines has correlated the alchemical recipes with modern chemical methods and terminology.

G. H.

PUBLICATIONS RECEIVED

Encyclopédie de la Pléiade. Histoire de la Science. Volume publié sous la direction de Maurice Daumas. Pp. xlviii + 1904. Paris, Librairie Gallimard, 1957. Price 4200 francs.

THIS book provides the general reader possessing some scientific knowledge, with an "encyclopaedic" account of succeeding epochs in the history of science up to modern conceptions of atomic structure.

Under the editorship of M. Maurice Daumas, the various sections have been written by well-known authorities on the subjects discussed.

In the chapters on the history of physics and chemistry, MM. Maurice Daumas and Rodolphe Viallard have given an interesting and critical account that surveys the history of these sciences from the period of the 16th century.

There are adequate indexes, and the text contains some useful tables and maps. The small format of this well-produced book has been attained by using thin paper for the printing.

Revue d'Histoire des Sciences et de leurs Applications. Tome XI, Nos. 1, (January-March); 2, (April-June); 3, (July-September), 1958. Paris: Presses Universitaires de France. (Annual Subscription to Great Britain and the Commonwealth, 27s.)

No. 1, has main articles on: Chronologie de la vie et des œuvres de René-Antoine Ferchault de Réaumur, by Jean Torlais—who also writes on: Réaumur philosophe, and Réaumur et l'histoire des abeilles; on: Réaumur embryologiste et généticien, by Jean Rostand; and Réaumur et les savants genevois, by Pierre Speziali. The section on "Documentation et Informations" includes contributions by A. Davy de Virville, on Réaumur dans la Mayenne, and by Arthur Birembaut, on Fontenelle, Réaumur et le gaz naturel. A section headed 'Analyses d'Ouvrages' completes the issue.

No. 2, contains articles on: Rôle de l'Histoire dans l'enseignement des Sciences physiques, by Charles Brunold; Notes sur le *De Motu tractatus* de Michel Varro, by Serge Moscovici; Réaumur mathématicien, by René Taton; Réaumur botaniste, by Ad. Davy de Virville; and on Réaumur et l'élaboration des produits ferreux, by A. Birembaut. E. J. Holmyard's recent book on "Alchemy" is included with the other reviews in the "Analyses d'Ouvrages".

No. 3, opens with a contribution by Armand Machabey, entitled: Quelques savants-musiciens de l'époque de Mersenne; on: Documents de l'Académie de Rouen concernant L'enseignement des Sciences au xviii^e siècle, by Geneviève Martin; two articles by Louis Dulieu, Le mouvement scientifique montpelliérain au xviii^e siècle,—and La contribution montpelliéraine aux Recueils de l'Académie Royale des Sciences; and Albert Gloden writes on: L'enseignement des Sciences à l'Ancien Collège de Luxembourg au xviii^e siècle.

Paracelsus: An Introduction to Philosophical Medicine in the Era of the Renaissance. By WALTER PAGEL. Basel/New York, S. Karger, 1958.

Robert Boyle and Seventeenth-Century Chemistry. By MARIE BOAS. Cambridge University Press, 1958.